The AMSAT® Journal

Volume 39, Number 6 Nov/Dec 2016

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07253 N8GNJ 2017.05

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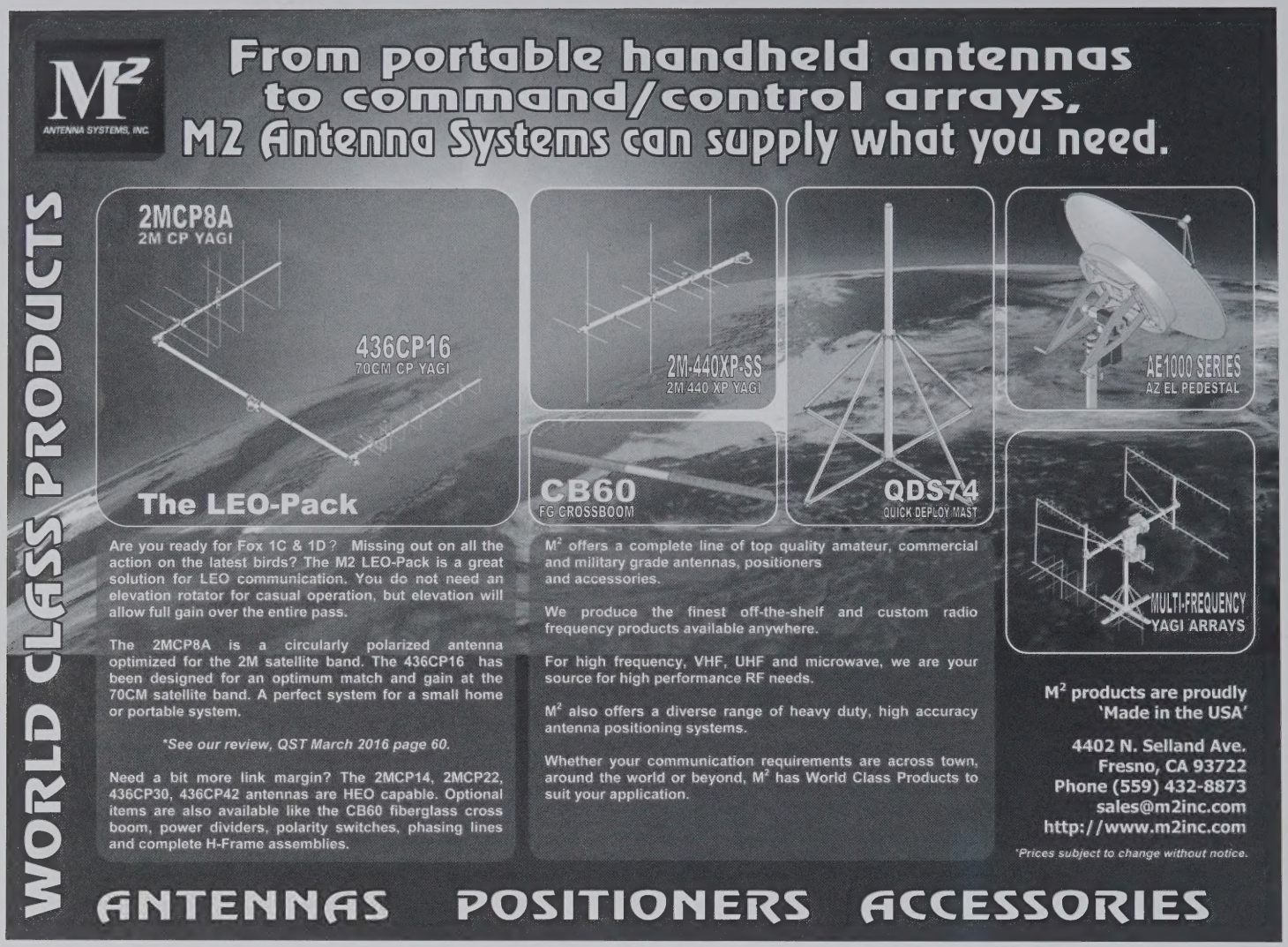
10605 Concord St., Suite 304
Kensington, MD 20895-2526

Periodicals
POSTAGE PAID
At Kensington, MD
and at additional
mailing offices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QUICK DEPLOY MAST
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The 2MCP8A is a circularly polarized antenna optimized for the 2M satellite band. The 436CP16 has been designed for an optimum match and gain at the 70CM satellite band. A perfect system for a small home or portable system.
*See our review, QST March 2016 page 60.
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The AMSAT Journal Needs Your Words and Wisdom

The AMSAT Journal is looking for interesting articles, experiences and photos to share with other AMSAT members. Writing for the *Journal* is an excellent way both to give back to the AMSAT community and to help others learn and grow in this most fascinating aspect of the amateur radio avocation.

Find a quiet place, sit yourself down, get out your laptop or pick up a pen, and ...

1. *Launch* your inner writer;
2. *Downlink* your knowledge and experiences to others by:
   - Sharing your adventures in the "On the Grids" column or
   - Describing your AMSAT career in "Member Footprints;"
3. *Transmit* lessons learned from operational and technical projects;
4. *Log* some of your more interesting passes across the sky; and
5. *Boost* others to a higher orbit of know-how and experience.

After your article lands in members' mailboxes, and the kudos start arriving for your narrative payload, you can enjoy the satisfaction of knowing you've elevated the collective wisdom of AMSAT to a higher trajectory.

Send your manuscripts and photos, or story ideas, to: **journal@amsat.org**.

Our editors are standing by!

AMSAT's Mission

AMSAT is a non-profit volunteer organization which designs, builds and operates experimental satellites and promotes space education. We work in partnership with government, industry, educational institutions and fellow Amateur Radio societies. We encourage technical and scientific innovation, and promote the training and development of skilled satellite and ground system designers and operators.

AMSAT's Vision

Our Vision is to deploy satellite systems with the goal of providing wide-area and continuous coverage. AMSAT will continue active participation in human space missions and support a stream of LEO satellites developed in cooperation with the educational community and other amateur satellite groups.

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The AMSAT Journal (ISSN: 1407-3076) is published bi-monthly (Jan/Feb, Mar/Apr, May/Jun, Jul/Aug, Sep/Oct, Nov/Dec) by AMSAT-NA, 10605 Concord St., Suite 304, Kensington, MD 20895-2526. Telephone: 301-822-4376, fax: 301-822-4371. Periodicals postage paid at Kensington, MD and additional mailing offices.

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The AMSAT Journal staff is always interested in article submissions. Whenever possible, submissions should be sent via e-mail to journal@amsat.org using plain text or word processor files; photos or figures in TIF, GIF or JPG formats. Kindly do not embed graphics or photos in your manuscript. We prefer receiving those as separate files. AMSAT-NA reserves the right to select material for The AMSAT Journal based on suitability of content and space considerations.

Apogee View

Barry Baines, WD4ASW
President

The past few weeks have been hectic ones for AMSAT as we enter the holiday season. Before the AMSAT Symposium @ Sea, the newly constituted AMSAT Board of Directors met in Galveston, Texas, on Wednesday and Thursday, November 9-10. The board re-elected for one-year terms the senior officer team that has served AMSAT for the past several years. The board then proceeded to go through an agenda that included an overview that I provided as president and which became the basis for the presentation I gave on the status of AMSAT at the Annual Meeting that took place on Sunday. The various departments gave their reports. We discussed AMSAT's financial situation, the status of our engineering projects, ARISS operations, the need to upgrade the amateur radio equipment on board the International Space Station, User Services, the need to upgrade our web-based services, the status of the AMSAT Journal, and Field Operations.

The board decided it would conduct a strategic planning process in early 2017 to help us evaluate our future direction. The last formal AMSAT strategic review occurred in February 2004, and much has happened in the past 12 years to warrant a fresh perspective. One of the primary responsibilities of the AMSAT Board of Directors is to provide the strategic direction of the organization while the senior leadership team focuses on the day-to-day management, with the president reporting to the board.

As we complete the last of the Fox-1 series satellites, we're now at a crossroads regarding our future satellite projects. We also have financial concerns as well as questions about succession planning. In the meantime, the external environment has evolved regarding partnerships, launch considerations, and technology. How AMSAT moves forward in the next five years likely will not be the same as we did 12 years ago when the last strategic planning review occurred.

Strategic planning is a process that allows the board to step back and understand AMSAT's current "SWOT" (Strengths/Weaknesses/Opportunities/Threats). The board will look at all facets of the organization's structure and ability to function in the current and projected environment. I expect that the board will re-examine the organization's mission — "The current Who and What is AMSAT?"— and vision — "What does AMSAT want to accomplish in the next five to twenty years?" While the mission defines AMSAT today, the vision is what provides the inspiration and motivation looking forward, which in turn defines what we aim to achieve as an organization, as well as how we'll measure success.

Also, the expected results of this process is an initial identification of resources needed to achieve the vision (financial, personnel and outside support) as well as a definition of follow-up action items. A key success factor is a commitment for follow-up; the creation of a strategic plan is but the first step in the process. The board ultimately is responsible for ensuring that the organization follows through on the actual implementation.

An effective strategic planning review also depends on following a process that encourages participation by all members of the AMSAT leadership (Board of Directors and Senior Leadership Team) coupled with key individuals within AMSAT who bring a perspective to the conversation. This could include former board and senior officers, as well as key personnel holding lower level positions who are making a difference for AMSAT.

As we move into 2017, I expect that the board will focus on preparation for the strategic planning process, including finalizing the timeframe, deciding where the team will meet, and selecting the outside facilitator to guide the process.

No sooner did the board conclude its deliberations on Thursday than it was time to board Carnival Liberty. The AMSAT Space Symposium@Sea was a success. Symposium participants and their families cruised from Galveston, Texas, to Mexico and back on a five-day sojourn that combined the amenities of a cruise ship, a moving footprint for multiple grid satellite operations, and the opportunity for a brief visit with our neighbor to the south, Mexico.

Uncertainty challenged the cruise itself. Engineering issues with Carnival Liberty required canceling the two cruises scheduled ahead of ours so that the ship could remain in port for repairs, which created some uncertainty as to whether the repairs would be completed in time for our scheduled cruise. Carnival Cruise Lines also announced a change in port destination from Cozumel to Progresso (also on the Yucatan Peninsula) before we knew whether repairs would be completed in time for our cruise to proceed. Fortunately, repairs were completed, and

our cruise proceeded on November 10, as scheduled, albeit with a new destination. There's an adage that says, "The fun is in getting there." Cruise ships are known for the food, entertainment, and variety of activities while underway. The AMSAT passengers had two additional amenities: (1) the Space Symposium sessions that took place on Friday, Saturday evening after departing Progresso, and Sunday; and (2) the ability for operators to work the satellites from the decks as we proceeded from one grid square to the next. The number of amateurs who took their satellite gear with them on the cruise (and had their International Amateur Radio Permits to operate from a Panamanian-registered ship) was impressive.

Carnival policy is to allow amateur radio operations from their vessels. The result was a 'gaggle' of satellite operators attempting to make contacts through all of the currently operational LEOs. There was also Operating challenges resulted from the cruise ship's significant RF environment (particularly on two meters) that made hearing the two-meter downlinks more difficult. Despite these obstacles, some contacts were made, key grid squares were provided, and land-based operators who make a two-way contact with operators on board ship earned a "Land Lubber" award.

We were fortunate to have a non-U.S. contingent of attendees from the U.K., Germany, Switzerland, Portugal, and Israel. Our banquet speaker was Peter Gülzow, DB2OS, who is AMSAT-DL's President. Peter's talk focused on the history of AMSAT-DL and its current activities. He also explained the upcoming Phase-4 amateur payload developed by Qatar Satellite Company as part of their Es'hailSat-2 geosynchronous satellite that is expected to fly in the second half of 2017. AMSAT-DL has served as a technical advisor for the amateur payload. The amateur payload will cover from Brazil to India while the satellite is centered over 260 East Longitude, providing television signals throughout the Middle East.

We were also fortunate to have AMSAT-UK Committee Member Graham Shirville, G3VZW (who is also the AMSAT-UK International Delegate and active ARISS participant, as well as the IARU Region 1 Satellite Coordinator), join us for Symposium@Sea. Graham attended the open sessions of the AMSAT board meeting and provided observations regarding some of our agenda items based upon AMSAT-UK's experience with similar issues. Graham also presented at the AMSAT Space Symposium about satellite activities in Europe, as well as highlighted amateur HDTV in conjunction with ARISS. As President of the British Amateur Radio Club (BATC), Graham is eminently qualified to discuss the successes and challenges of receiving digital TV signals from the ISS.

The AMSAT Annual Meeting took place on Sunday afternoon. November 13, in accordance with the By-Laws of the Radio Amateur Satellite Corp. Our original intent was to provide an Echolink connection from Carnival Liberty to allow members not present at the annual meeting to participate. Unfortunately, the internet connection available from the ship was much more limited than we anticipated, and we were not convinced that a reliable Echolink connection could be established and maintained throughout the annual meeting.

I encourage members who were not present to read my comments at the annual meeting, transcribed by AMSAT Editor, Joe Kornowski, KB6IGK, in this issue of the Journal, as well as review my slide presentation available on the AMSAT website. My overview highlights the current status and key accomplishments in 2016 throughout AMSAT, including organizational structure, Engineering, AMSAT Journal, Field Operations, IT and finances. I also outlined 2017 goals and expectations.

We accomplished much in the past year, but I expressed concerns in my presentation about membership and how low membership levels impact AMSAT's financial strength. I've noted these concerns previously at the AMSAT forums at Hamvention as well as prior annual meetings.
The slides coupled with Joe's transcription should be self-explanatory, but if you have questions about what I presented, please feel free to e-mail me with your questions (wd4asw@amsat.org).

At the Annual Meeting, we also recognized key volunteers who have done so much to make AMSAT a success in 2016. This year we recognized 43 individuals, of which nine were present at the Annual Meeting. Each received a Certificate of Appreciation as well as a small crystal memento commemorating their 2016 support for AMSAT. Award recipients not present will receive their recognitions by mail, and we will publish the names and citations they were given in The AMSAT Journal. Some amazing people are doing so much in the areas of Engineering, Field Operations, ARISS, Operations, AMSAT Journal, User Services, Education and overall leadership of AMSAT. Recognizing their efforts is important, and it is certainly appropriate to highlight their accomplishments and thank them for what they do for AMSAT.

This year's AMSAT Space Symposium received outstanding prize support from several vendors. Kenwood donated a TH-D72 HT which features full duplex (excellent for LEO satellites); the winner was Andy McAlister, W5ACM. Flex Radio Systems provided a gift certificate valued up to $300 towards a Flex 6000 series radio. The winner was Jerry Buxton, N0JY. Elecraft donated a XG3 Programmable Signal Source won by Graham Shirville, G3VZW. M2 Antenna Systems donated a 2M-440XP-SS dual-band antenna suitable for LEO satellites won by Randy Berger, WA0D. AMSAT donated an assembled LVB Tracker won by Wyatt Dirks, AC0RA. Additionally, eight individuals won $10 ARRL Gift Certificates. Joe Spier, K6WAO and Bob Ludke, K9MWN, each won $100 gift certificates from Advanced Circuits. Alan Biddle, WA4SCA donated an AMSAT/ARRL FT-817 CAT Interface kit designed by WA8SME and won by Graham Shirville, G3ZW. Thank you to each of our prize donors! Should you have an opportunity to interact with any of our prize donors at a hamfest or some other venue, please express your appreciation to them as well.

While not everyone may have been excited about the prospects of having the AMSAT Space Symposium@Sea, everyone who participated was very positive about the experience. The satellite operators who made contacts while at sea are an impressive group, and I certainly saw a variety of equipment and antenna setups that provided me with an opportunity to pick the brains of some very accomplished satellite operators. I particularly appreciate the number of foreign nationals who joined us on the cruise. Their active participation enhanced the quality of symposium and allowed us to reaffirm our common goal of "Keeping Amateur Radio in Space."

We already have started conversations about the 2017 AMSAT Space Symposium that will take place on Terra Firma. Once we make arrangements regarding hotel and dates, we will make an announcement. My expectation is that we will announce the location and dates in early January.

Organizational Matters

At the AMSAT Space Symposium, I also announced the appointment of G. Gould Smith, WA4SXM, as Director-Field Operations. Patrick Stoddard, WD9EWK, is now the Lead Local Coordinator. Gould served previously as Director-Field Operations from 2004-2008 and later as VP

User Services. Due to medical issues, Gould withdrew from AMSAT in 2014, and we lost a key individual who had done so much for AMSAT. Fortunately, Gould's medical issues abated, and he is again excited about helping AMSAT.

Patrick, WD9EWK, as our Lead Area Coordinator, essentially serving as Gould's Executive Officer. Together, Gould and Patrick will work to enhance the Field Organization. Our Area Coordinators represent AMSAT at the local level (i.e., AMSAT ambassadors), educating amateurs and others about amateur radio satellites. As active AMSAT members, area coordinators typically give club presentations, represent AMSAT at local hamfests, and serve as "elmers" to new satellite operators. In 2016, the Field Organization handled 28 events around the country, including hamfests (Dayton, Orlando, Pacificon, Huntsville, and Boxborough among others), club presentations (such as Boston, Greensboro, Shelby, the Queen Mary), Makers Fairs/Science Fairs (Atlanta and University of Arizona Science Fair) as well as smaller events.

Initially, Gould will spend some time getting back up to speed on the current status of the Field Organization and establishing a line of communication with the Field Ops Team. Patrick likely will focus on sharing his passion and expertise at demonstrating amateur satellite operations and representing AMSAT at numerous venues. In 2016, Patrick handled 13 events in California, Nevada, and Arizona. Patrick's enthusiasm for representing AMSAT is impressive, and I anticipate that he will continue to share his expertise with the Field Ops Team.

As an AMSAT member, I hope you recognize the potential you bring representing AMSAT either informally or as a member of the Field Ops Team wherever you're located. I encourage you to contact Gould (wa4sxm@amsat.org) if you are interested in helping Field Operations to familiarize the amateur radio community and others about amateur radio satellites and their capabilities.

As many are aware, the 2017 Dayton Hamvention is changing venues from Dayton to Xenia, Ohio. During the AMSAT Space Symposium@Sea, Steve Coy, K8UD, provided a guided tour of the facility at the Green County Fairgrounds through a drone-based video that provided an excellent overview of the area. Steve is a member of the Hamvention Committee and noted that plans are moving along well for the 2017 event. Expect the Hamvention website to be updated by early January regarding tickets, parking, the layout of the facility, etc. Steve made it clear that the Hamvention Committee is sensitive to the needs of AMSAT both regarding booth space and also space needed for satellite demos outside the building where AMSAT would be situated. Steve noted that the Forums would be held on site with no reduction in forum space compared to Hara Arena. AMSAT has enjoyed great forum attendance, and the Hamvention Committee is sensitive to that fact.

I am also pleased to note that our Dayton Team Leader, Steve Belter, N9IP, will once again lead our Hamvention efforts in 2017. Steve has done a magnificent job the last four years, and having him serve as this year's team leader as we move into a new venue will certainly make the transition to a new location less painful. With a team of over 50 people who assisted AMSAT in 2016, I look forward to having that team quickly adapt to the new location.

The Holiday Season

As 2016 draws to a close, I wish you and your family a most joyous Holiday Season. AMSAT has accomplished much in 2016, not only in terms of the recently concluded AMSAT Space Symposium but the significant engineering work that has resulted in the potential for having four Fox-1 satellites flown in 2017. While launch schedules may change due to circumstances beyond AMSAT's control, our engineering team currently has two CubeSats ready to fly (Fox-1Cliff and Fox-1D on a SpaceX launch), one satellite having completed environmental testing and awaiting mission readiness review (RaxFxSat-1/Fox-1B is manifested on ElaNa-XiV expected to launch in March 2017), and the fourth expected to be ready for a late 2017 launch (RadFxSat-2/Fox-1E on ElaNa-XX). We're all anxious to see these birds flown in the not-too-distant future.

The Holiday Season also marks a turning point for my wife Kathy (WD4ASX) and I as well. After 38 years serving as a Lutheran Pastor in the ELCA, Kathy retired on October 31. After Thanksgiving, we'll be in the process of relocating from Westborough, Massachusetts, after 10 years of her ministry at Good Shepherd Lutheran Church. We have purchased a home in Keller, Texas, so that we can be near one set of grandchildren during the winter/spring months and another home in the Boston area to be near the second set of grandchildren in the summer/fall months. In essence, we're becoming "snow birds."

Entering retirement and relocation places significant stress in terms of both actual moving and setting up new households as well as entering a new phase of our lives. I will, of course, continue to fulfill my responsibilities as AMSAT President during this transition, but if I'm unable to quickly respond to your e-mails or queries over the new couple of months, please be tolerant. A change in venue provides new opportunities to interact with AMSAT members at a local level, and I look forward to attending hamfests that will now be close to my new residence in North Texas (such as Ham-Com), as well as continuing to support AMSAT at locations in New England (such as Boxborough). As in prior years, I also expect to be present for Hamcation (Orlando) and Hamvention (Dayton/Xenia) as well in 2017.

Happy Holidays!

eBay Sellers Donate to AMSAT

Are you an eBay seller? One item, ten items, or a full-time business you can donate a percentage of your winning bid to AMSAT.

To do so, do not list your item with the basic listing tool, select advanced tools. eBay will give you a warning message that it is for large volume sellers, however this is where the eBay for Charity tool is found.

You can "select another nonprofit you love" and search for either AMSAT or Radio Amateur Satellite Corporation. Choose the percentage amount of the sale you would like to donate to AMSAT, and boom!.

When your item sells and the winning bidder pays, eBay will deduct the percentage from your take and forward it to AMSAT.

Sometimes we are getting rid of our old equipment, sometimes selling something new. In any case, please consider giving a piece of the pie to a new satellite and choose AMSAT for your eBay Charity.

AMSAT Board of Directors Meeting

Paul Stoetzer, N8HM
Secretary

The 2016 AMSAT Board of Directors meeting was held at the DoubleTree by Hilton Hotel Galveston Beach in Galveston, Texas, on November 9 and 10, 2016, before the 2016 AMSAT Space Symposium held aboard the Carnival Liberty. Full minutes will appear in a future issue of The AMSAT Journal. Following is a summary of the presentations made during the meeting.

[Sharon McGwier, N1SMM, photo.]

Election of Officers

The first order of business after the opening of the meeting was the election of officers.

The board voted upon and filled the following positions:

President: Barry Baines, WD4ASW
Vice-President Operations:
Drew Glasbrenner, KO4MA
Vice-President Engineering:
Jerry Buxton, N0JY
Vice-President Human Spaceflight:
Frank Bauer, KA3HDO
Secretary: Paul Stoetzer, N8HM
Treasurer: Keith Baker, KB1SF/VA3KSF
Manager: Martha Saragovitz

The following senior officer positions remained open awaiting appointments:

Executive Vice President
Vice-President User Services
Vice-President Marketing

President's Report

AMSAT President Barry Baines, WD4ASW, then delivered his report on the status of the organization. See the transcription of the President's Report as delivered at the 2016 Annual Meeting elsewhere in this issue.

Secretary's Report

AMSAT Secretary Paul Stoetzer, N8HM, began by requesting approval of the minutes of July 19, 2016, Board of Directors teleconference. Following approval of the minutes, he delivered the Secretary's Report. He noted that three formal meetings of the Board of Directors were held via teleconference since the 2015 Board of Directors meeting held in Dayton, Ohio. A December 5, 2015, teleconference was held to approve the 2016 budget. Additional teleconferences on February 29 and July 19 occurred to approve the minutes from prior meetings.

Paul next discussed the 2016 Board of Directors election. Of 3,174 ballot packages mailed, 697 were returned, for a participation rate of 22%, up slightly from 21% in the 2015 election.

Treasurer's Report

AMSAT Treasurer Keith Baker, KB1SF, noted that AMSAT remains solvent. He reported that 2016 was a fiscally challenging, but a good, year. Keith expressed long-term concerns about member-based revenue, with uncertainty regarding both AMSAT's share of multiple projects and the impacts of the 2017 North American economy.

Keith also raised the question of whether AMSAT should return to a full audit of the organization's finances. A full-audit proposal was dropped in 2011 because of cost, but Keith observed that some funding sources might require a full audit of an organization like AMSAT to be eligible for grants. The costs and benefits of this step will need to be determined by the board.

The board approved Keith's request that AMSAT's current financial firm, Berlin, Ramos & Company P. A. in Rockville, Maryland, be appointed to perform an audit or review of a type to be determined.

Manager's Report

AMSAT Manager Martha Saragovitz noted that this had been a challenging year in the office with the loss of both of her long-time volunteers, but that most of the office operations are going smoothly. She noted some concerns about ongoing problems with the online store.

Operations

AMSAT Vice-President Operations Drew Glasbrenner, KO4MA, noted that AMSAT has two operational satellites, AO-7 and AO-85. AO-7 is in full sunlight currently, switching between Mode A and Mode B every 24 hours. AO-85 is very easy to receive but suffers from receive sensitivity issues and is not as popular as expected. The satellite very rarely needs commanding. AO-85 successfully has demonstrated the high-speed data mode required for experiments on Fox-1Cliff and Fox-1D.

Drew also mentioned that SSTV demonstrations might be planned on AO-85, particularly after future Fox satellites are launched. Once Fox-1Cliff and Fox-1D are orbiting, and while they remain nearby, he plans to keep one of them active with their L-band uplink.

Drew estimated that a total of 400-500 users of AO-85 were active worldwide , between telemetry collectors and transponder users.

Noting the many non-AMSAT-NA satellites in use, Drew suggested that the high number of LEO satellites in 500 km – 800 km orbits meant that AMSAT-NA should concentrate on strategies for higher LEO orbits. He cited two planned constellations going to 1200 km or higher.

Drew mentioned that the AMSAT Twitter account is "going gangbusters," with a current total of 9,493 followers. He suggested that AMSAT can leverage its social media following if it can better coordinate information releases. The AMSAT North America Facebook group has 2,765 members and the AMSAT corporate Facebook page has 3,174 likes. Social media has driven

online fundraising and membership drives.

User Services

The AMSAT Journal

AMSAT Journal Editor, Joe Kornowski, KB6IGK, reviewed the *Journal's* achievements over the past year, noting implementation of a style guide and editorial efficiencies, a design refresh, new content features, and relationships with other content sources such as *QEX* and *QST*. Joe advised the board on the ongoing challenges of obtaining content for the *Journal* and increased reliance on non-AMSAT sources.

AMSAT News Service

AMSAT Vice-President Educational Relations and ANS Editor Joe Spier, K6WAO, began by mentioning that ANS was now being distributed on OuterNet. He described a challenge with column formatting for the old format designed for distribution via packet BBSes. It takes 4-5 hours a week producing the draft and 1-2 hours to get the final version out.

Joe also noted that a primary advantage of ANS is how ANS articles are re-distributed to various news sites, including the ARRL, eHam, QRZ, Southgate, etc.

Field Operations

Barry noted that Gould Smith, WA4SXM, was taking over the Field Operations team, as previously noted. He expressed hope that Gould would improve communications with the area coordinators and senior leadership team.

Dayton Hamvention

The major challenge for the Dayton Hamvention in 2017 will be the transition to a new site. Barry stated that we have not heard from the Dayton Amateur Radio Association (DARA) regarding the setup for next year at the new site. DARA member and AMSAT Treasurer Keith Baker, KB1SF/VA3KSF, discussed some details of the new Hamvention site.

Awards & Contests

Bruce Paige, KK5DO, AMSAT Director of Contests and Awards, opened by noting he had received requests for new contests and awards. He remarked on the longstanding gentleman's agreement regarding no contests on satellites, except for Field Day. He noted that nothing new regarding awards had been done in awhile.

Bruce also reviewed the 2016 Field Day results and noted some criticism of the W4AMI Satellite Operator Achievement Award for encouraging excessive amounts of repeat QSOs on FM satellites.

AMSAT Lab and Storage

Lou McFadin, W5DID, reviewed the status of the AMSAT lab and storage facilities in Orlando. Parts and extra supplies from ARISSat-1 and other satellite projects are stored there. The stored fully functioning vacuum chamber, 1 x 10^-4 tor, doesn't quite meet the requirements for certifying CubeSats.

Barry noted that most of the stored materials are from the Microsat, AO-40, and ARISSat-1 projects. When Barry asked how much of what was stored needed to be kept, Lou responded that some of the storage was used for ARISS, but that some of it could be cleared out. Martha also remarked that perhaps some items stored in the AMSAT office could be shipped there.

AMSAT Education Outreach

Joe reviewed his year and activities with Educational Outreach, including service as an ARISS mentor for an ARRL National Parks on the Air event with the Lewis and Clark National Historical Park and a presenting on STEM and the Fox class satellites at the 2016 Hamvention. He also moderated an ARISS telebridge contact for the University of Nebraska, Peter Kiewit Institute, Jamboree on the Air Event with a 5,000-person audience.

Next May, Joe is scheduled to present at Carol Perry, WB2MGP's instructor's forum. Available resources include a Fox class physical mock-up, Fox solar panel experiment, and a Fox cardboard model.

He described the "NxtGen Crystal Radio" project. One questions often asked is "How do you get interested in radio?" The answer used to be crystal radios. The modern equivalent would be an SDR (SDR play / magmount based loop antenna, cables) and a FoxTelem DVD with instructions. The budget is $3,000 - $3,500 total for 10 units. The idea is to have 10 units to give to instructors at the ARRL Instructors Forum. A FoxTelem DVD would have projects including correlating solar panel voltages with MEMS gyro data.

Engineering Update

AMSAT Vice-President Engineering Jerry Buxton, N0JY, delivered the Engineering Update. A transcription of Jerry's presentation on AMSAT Engineering during the symposium appears elsewhere in this issue.

AMSAT IT

AMSAT IT Team Leader Joe Fitzgerald, KM1P, reviewed the status of AMSAT IT. He proposed a project to refresh the website, update the store, and enable web-based membership services in one integrated step. He presented a timeline and budget estimate for this type of system. Discussion of the proposal revealed that the funds to pursue such a project remained in the 2016 budget, and the board agreed that the project should move forward.

2017 Symposium Proposal

AMSAT Vice President-Educational Relations Joe Spier, K6WAO, presented a proposal to hold the 2017 AMSAT Symposium and Annual Meeting in Reno, Nevada. Further consideration was deferred for more details regarding hotel and meeting space costs.

ARISS Updates

ARISS International Delegate Dave Taylor, W8AAS, gave a presentation on the status of ARISS. NASA's Space Communication and Navigation (SCaN) Program and the Center for Advancement of Science in Space (CASIS) are now the major benefactors and stakeholders, with 1,057 school contacts made among 1,090 schools since December 2000. Two new states have been added this year, North Dakota and Rhode Island. The contact with North Dakota was contact 1000.

Tim Peake's mission was very successful. The HamTV downlink was first operational during a school contact with Peake on February 11, 2016. A chain of ground stations in Europe operate HamTV, but 3-5 stations in various parts of the U.S. aligned with the ISS ground track are needed.

The 15th anniversary of SSTV was commemorated in an event on April 11-14, 2016.

The ARISS-US Executive Team (Frank Bauer, Debra Johnson, Kenneth Ransom, Dave Taylor, and Rosalie White) met with SCaN representatives at NASA Headquarters on July 22, 2016, to develop a strategic plan for ARISS-US.

CASIS and SCaN request ARISS-US to support multiple regional conferences (about 7-9). ARISS is working on new, shippable displays and updated handout materials. ARISS-US reports weekly and quarterly to SCaN.

This past year was transformative for ARISS,

with substantial growth and tremendous accomplishments. ARISS has proven the utility of HamTV and is developing new, robust hardware systems to expand and improve its QSO experience. To sustain this momentum and continue to grow, ARISS needs to expand its volunteer team and obtain additional funding for hardware.

ARISS Hardware

Lou McFadin, W5DID, gave a presentation on current and future hardware. He reviewed the current equipment aboard the ISS.

Currently, the Kenwood TM-D710 in the Russian Service Module is operational. The VHF Ericsson station in the Columbus module has failed, likely due to a cosmic ray upset in its memory. The VHF Ericsson radio has been replaced by the UHF Ericsson radio now operating on 437.550 MHz. The Kenwood TM-D710 radio in the Russian Service module is being used for school contacts, and the HamTV transmitter in the Columbus module is sending blank video.

ISS Ham (the ISS Program name for ARISS hardware) exists in both segments of the ISS, but it's not easy to move equipment from one segment to the other as power in the Russian Service Module is 28 V DC while Columbus is 120 V DC.

The path forward is to develop and deploy a TM-D710 radio in the Columbus Module with higher power to replace the Ericsson. An identical unit is to be used in the Service Module.
An ARISS-built power supply is being developed that will be compatible with the power systems in both modules.

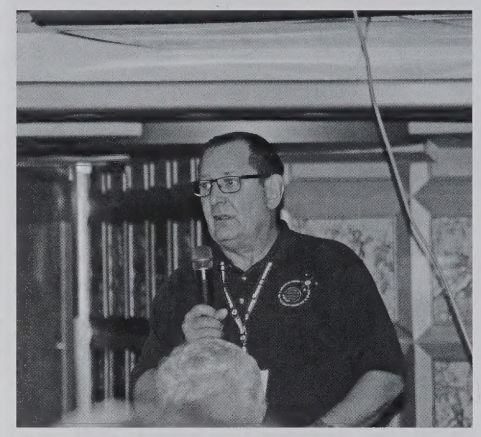
Lou also discussed a long-term path that includes a next generation ham system commandable from the ground where astronauts and cosmonauts could use a handheld radio anywhere on the station and communicate to the ground using a transponder.

Intellectual Property Policy

Barry noted that an intellectual property policy was necessary to satisfy employers of AMSAT volunteers. While there has been such a policy in the past, a new document needs to be developed and approved by the Board of Directors. Barry read a draft policy to the board and further consideration was deferred until a future meeting.

Space Symposium: Engineering Update

Jerry Buxton, N0JY
V.P. Engineering
(Transcribed by Joe Kornowski, KB6IGK)



[Bob McGwier, N4HY, photo.]

Fox-1 Program

The Fox-1 Program was introduced in 2009 as AMSAT's first CubeSat project because we believed it was the best opportunity for us to reach Low Earth Orbit. As part of NASA's CubeSat Launch Initiative (CSLI), we were able to get a free launch. Also, the CubeSat standard design provides more launch opportunities. AMSAT's plan was not just for one but a series of CubeSats that would have common systems and bus, and that could host a variety of educational experiments.

The Fox-1 CubeSat program represents a marvel of miniaturization. We decided to create our own bus design, rather than a commercial design, that had 8 millimeters between PCBs, with nine PCBs/Systems in less than a 10-centimeter stack. We included a robust RF system, with 800 milliwatts output, AFC and a NiCad battery for longevity. For a microcontroller, we used a powerful yet low power STM32L151 MCU, as well as a MPPT for solar electric charge control.

As part of the Fox educational mission, we arranged for a variety of university experiments. These included Vanderbilt University's Institute for Space and Defense Electronics (ISDE) looking at radiation effects, Virginia Tech testing a jpeg camera, and the University of Iowa conducting radiation belt mapping. Additionally, AMSAT took advantage of one of the open slots on Fox-1Cliff and 1D to build what we call the downshifter, and L-band down-converter so that we can have L-band uplink and VHF downlink. What it does is that it is not a receiver, but a down-converter that receives the L-band signal and converts it down to the 435 dot whatever uplink frequency for that particular bird and feeds it into the receiver.

We have three CSLI launches, and we purchased a commercial launch for two others. Originally, Fox-1Cliff was intended to launch through Spaceflight. It turned out that Spaceflight also had a vacancy and another opportunity for us to partner with them to get two satellites launched. So, we decided to launch both Fox-1Cliff and Fox-1D in the upcoming SHERPA maiden voyage. If everything goes according to the planned dates, we should have a total of five Fox-1 satellites — the entire bunch — launched in about 30 months. AO-85 launched in October last year, and the remaining four really could all fly in 2017. That's the way it lines up right now.

Fox-1A launched October 8, 2015, and is still working very well. RadFxSat/Fox-1B is scheduled to launch March 16, 2017. As for Fox-1Cliff and Fox-1D, because of our non-disclosure agreement, I can't say very much about that. But when SpaceX is ready to return to launch, we will be ready to fly very soon after that. I expect that will happen pretty soon. You can probably get a lot of that information on the Internet; I'm just not allowed to say it.

RadFxSat-2/Fox-1E, which was selected for the CSLI [CubeSat Launch Initiative] ELaNa launch in February of this year, was at the top of the list for first dibs on a launch. They offered us a launch in December 2017, and Vanderbilt and AMSAT agreed that would be a good orbit, so we're slated to get several of them up hopefully in 2017.

AO-85 proved the concept of the Fox CubeSat design. We proved that it works and works well. There were a lot of good lessons learned. If you've done this, and all of you that did do it, you know how much fun it was to find out all the things that we thought we knew but didn't really. But that's all experience. And that's part of the deal. You have your successes, your failures. You put them together, and you get better. So, we got five satellites that gave us a lot of experience in improvement, plus rapid aging, adrenaline rushes, sleeplessness, nervous tics and things like that.

We got lots of telemetry that is coming down. The DUV [Data Under Voice] works

Fox-1A Telemetry Leaderboard

Ground station	DUV Frames	9k6 Frames	Last 7 days
SP6CGR	185027	65	5926
SP5ULN	157865	15	1170
WA4SCA	104031	17	2267
N8MH	98368	748	1451
G0MRF	90926	28	884
PB0AHX	86838	35	2895
G7WIQ	82294	0	2937
K4OZS	77318	429	1697
DJ4MDH	66806	0	1555
VE3NB	65804	32	0
SP3MCY	60971	6	1190
KD8CAO	56837	42	0
AC2CZ	55854	78	897
KB6LTY	52953	0	1138
ON4HF	47414	4	46
W2BFJ-Wn1	44554	127	1040
WA6FWF	42980	17	3276
M0SAT	39220	27	1539
PU3XGS	34059	0	4

Fig. 1 — AO-85 Telemetry on amsat.org.

very well for that because a lot of people are interested in telemetry, a lot of individuals are interested in working the satellite. In the one FM channel, we can get all of that. The telemetry that comes down is excellent data for our science partners, which so far is only Vanderbilt, but they are extremely pleased with the amount of data we've been able to bring them.

In the screenshot of the AMSAT telemetry webpage (Fig. 1), you can see tons of frames that are downloaded. Some of the northern latitude stations, with 64 degrees inclination, benefited greatly from several passes during the day.

Vanderbilt ISDE wrote an article about it in the September/October *AMSAT Journal* about their experience with what they were able to do with their science — very pleased with it. They've been a great partner for us. That was the original intention at the beginning of the Fox satellites for 1A, and then 1C is where we will fly their spare. And then we've got RadFxSat and RadFxSat-2. It's worked out to be a great partnership for both of us to be able to work together on understanding the radiation effects in space for our use and desire to use commercial, off the shelf stuff, because that's the way we work.

According to the science data in the *Journal* article, Vanderbilt noticed the rate of upsets that they are getting. I encourage you to check that out. It's a very good article. In looking at their science, they also thought that they had a possible correlation with what we've seen in our Internal Housekeeping Unit (IHU) upsets. We have a suspicion that the IHU resets, which you may or may not even know are there unless you are looking at the telemetry, and you see the reset count number. They appear mostly to be happening over the South Atlantic Anomaly, which is something that was expected when the satellites were designed. And it's also included as part of the design.

We expected the IHU was going to reset one or more times per day. That's working out very well, the plan to handle that — the radiation mitigation, if you will. If the IHU reboots, it just starts over, comes up and picks up where it left off. It works very well in that sense, and also because we designed it so that the FM repeater will work without the IHU. We have evidence of a reset where the QSO continues because it flipped right over the FM radio. They kept talking. The IHU rebooted. There might have been a loss of audio for a second when it came back up and then took over the audio again. So, the IHU is handling itself well. The Vanderbilt data seems to indicate an increased rate in their upsets as our apogee precesses and now moved more towards the equator, and especially through the South Atlantic Anomaly, it's higher. And they see a greater rate of hits as well, and they've suggested that this might explain our more frequent IHU resets.

With the Fox-1 program, we have a lot of great relationships with NASA. We work very closely with the mission coordinators, the launch providers themselves, the test facilities, particularly NTS where we do a lot of our environmental testing. At NTS in Orlando, we had to have a block of metal machine to put a CubeSat test pod on their vibration table. We loaned that to them so that they could use that for any other CubeSat test that might come along. We've got a great partnership with them.

It opened the door to working with more educational institutions. I get a lot of inquiries from other universities, other schools, which are interested in flying science on the launches. And that's what we designed it for. That's great! It's part of AMSAT's outreach for education. So, we can bring the data to the classrooms, to the telemetry, and we get more radios in space.

We are working on providing our radio communications systems for other CubeSats, not flying only our CubeSats, but giving them an FM radio or a 1E type transponder working in a CubeSat. We've got a couple of things in the works with that.

RadFxSat

RadFxSat will be the fourth Fox-1 produced, and that demonstrates the maturity of the system. In putting this one together, as the fourth, it's kind of like assembly line, off the shelf type of thing — BS! It's tough no matter how you look at it. It takes us probably a year, even to take something like what we've done before, put it together, test it, and make it work because every one of them will fail in different way every time you build it. They are tricky in that sense, but we're all familiar with Murphy, and Murphy is all over these things. It's amateur radio. It's not easy. We want ours to last a long time. AMSAT has always put up satellites with the intention that it is not a three-month or one-year or some short period. We want it to last the lifetime of the orbit. It takes a lot of engineering to work within the type of budget we have to make sure that we can build something that's likely to be reliable and be able to hold together for the duration of an orbit.

All the Fox-1s are designed for a five-year orbit. All the orbits they will be flown to are designed for them to reenter within 25 years because that's the requirement for orbital debris. Fox-1A will be the longest. It could last over 15 years in its orbit. The rest are in the six to seven-year range.

ASCENT: Cube Quest Challenge Phase 5

ASCENT is the Advanced Satellite Communications and Exploration of New Technology. It's a program that AMSAT began two years ago. It's a skunk works. We need to have people working on various ideas. And so the board of directors approved the idea and funded this group of people, which is a gathering of a bunch of engineers to play around a little bit to come with new things as we move forward with satellites. Inside that, we have a few things that are specifically going on, like the Cube Quest Challenge (CQC), Phase 5. It came along a little over a year ago, a partnering with Ragnarok Industries to fly on their Heimdallr CubeSat, a 6U CubeSat. They are entered in the NASA CQC. NASA is encouraging companies to develop a CubeSat that will go to the Moon, or beyond, and transfer large amounts of data. They chose the Lunar Derby they asked us, through their connections with some of our AMSAT members, to help them out with the communications package. So, we're working on the RF package. Once the mission is complete, the idea is that after they have their 28 days of how much data they can get from the Moon back to the Earth, then they are going to turn it over to AMSAT to be used as a lunar-orbiting phase 5 amateur radio transponder. Because

of the distance, because of the power, we're figuring we'll get maybe six channels out of it, digitally speaking, although that is TBD. It will probably have a meter dish on the ground. The AMSAT Ground Terminal is being designed, in part, to provide the hook to this because it will be the "five and dime" — five gigahertz up, ten gigahertz down — band plan.

The plan is to use a Rincon AstroSDR for the radio. Originally, we started to work on our own radio, but we also had timeline concerns, as well as NASA's concerns to overcome. We will fly a commercial radio, but continue to work on our own, of course. It's got some patch antennas that have been designed to work on the 6U. It's going to have a power amplifier that is designed by some of our AMSAT team members, very similar to what will be used on Phase-4B, and a low noise amplifier as well, because it's the same five and ten gigahertz design. So, that helps us get more mileage for our money by developing something that usable on more than one satellite.

We also plan to use DVB-S2x implementation because it handles the low SNR environment for the trip to the Moon. And it does have an omni antenna for backup to be able to recover if it points in the wrong direction. The current status of that project is Ground Terminal 4. In late March 2017, five CubeSats are vying for a free launch on this EM-1 mission. And NASA, like our CSLI missions, is going to pay for everything — get it on the rocket, and launch translunar. So, the first three get to fly. The fourth and fifth will go on standby, and the rest are on their own, so to speak. We're looking right now at putting together results and pictures of working hardware, as well as detailed descriptions of operation. That's from our communications point of view. The launch would occur in late 2018, and the competition ends 365 days after launch. The way the competition is designed Ragnarok intends to try to boost it a little bit out of the close lunar orbit to an L1 and let us use it, which could last a while. If it has to remain in lunar orbit at the end of 365 days, then they have to crash it. That's the rules of the contest.

We may get a satellite out of it; we may not. But the real idea behind it is that it's an excellent development working in a 6U CubeSat format, not only in the first phase five that we might have. We learned a lot about ranging and the low SNR modulation, the power amplifier, low noise amplifiers, antennas. And that is stuff we can take with us and work with on our own HEO/GTO or even LEO type satellites. It's an investment not just in this one area, but something that can be used in a lot of areas, including the Phase-4B.

ASCENT: SDR/SDX

The ASCENT team is also working on the development of our own SDR/SDX transponder. It's a continuation of the original CQC, something that we would intend as it is designed on the 1U form factor. It could fly on a variety of satellites. I'd like to see something that would cover even 20 megahertz/15 meters on up. We can make it be any radio we like, so it gives us opportunities. It is something we can put on our satellites to fly as we like. It will give us a lot of opportunities to operate a lot of different radios. That's one thing the Foxes weren't. They were FM. We had a chance for the fifth one, so we said let's see if we can put a linear on it as well.

It's in the early stages. The Texas contingent — five of them all working in the Dallas area — collaborates on the multi-purpose SDR. The AMSAT Ground Germinal team is also doing some exploration into FPGA, and so we have two paths going to that. It all fits together with AMSAT's plan to have this development going on. And what is learned can also be applied to the AstroSDR, as we have opportunities to use that.

These teams are excited and motivated. This is what ASCENT is about. Other than CQC, and a little bit of the Ground Terminal for Phase-4B, there is no eminent target. It's a sandbox right now. Go off and play. We'll give you a little bit of money. So, it's difficult, but they're having fun, and that's the challenge. The "ENT" part of ASCENT, exploration of new technology — there's a lot of documentation coming out of the Ground Terminal project SDR development. In the past, we had problems with that. Things were built, and there was some documentation. But most engineers, including myself, don't like to write stuff down. So, when you go to do the next thing or want to refer to how someone did something before, that got lost.

We're making a significant effort, which Tony [Monteiro] started with some of his engineering redesign to make sure that we document as much of this as possible. There's a lot of information on our Fox satellites on our servers. A ton of it is in emails that go to lists so that several people or whole groups understand what's going on. The Texas contingent has their own server with their information. The Ground Terminal being an open source type of thing, non-ITAR, is up on GitHub. Anybody can get in there and see that. Two separate paths increase diversity and reduce risk.

AMSAT Ground Terminal

Ground Terminal was proposed when we came up with the "five and dime" frequency scheme. And that came from CQC. We were looking at what frequencies would work best. What frequencies would be best to get cheapest parts for? Five and ten gigahertz fit nicely. And also they are a couple of bands that are not, right now, under assault by commercial entities. And they have a lot of bandwidth. So, we have a lot of space to play up there.

The idea is to design a five and dime ground terminal that costs less than $1000. That original target was set as part of the Phase-4B project. We want everybody to be able to buy or build one of these because it is going to be a change. A lot of people have an investment of probably equal value in a VHF and UHF type of station. And that kind of helps with the transition. We're looking at complete stations for sale, kits for sale, where plans are available, where to acquire parts, and targeting a dish size of one meter or less, depending on what the satellite is. For example, a GEO could get by with a DBS type size, and that fits in very well with people who are HOA-restricted because you could theoretically stick a second dish on your roof and nobody would know the difference.

This one has worldwide team membership because it is not covered by ITAR or EAR. We figured it would be much better for development if we didn't keep it closed in as we do with most AMSAT stuff because we need to be very careful about that. But it is all terrestrial. The whole thing is a terrestrial development in this particular sense. It is a ground station used here on Earth. The open source development helps to open it up to lots of different activity.

Right now they are looking at a variety of SDRs to be used as in the intermediate. You don't necessarily have to use any particular one. You can take what you have and hook it into the rest of the equipment — cheap and easy to find hardware. There's been some great antenna design work. And Michelle Thompson, W5NYV, is my captain of that. She runs that whole group. And she posts a lot of updates on YouTube. That's it for now, but stay tuned.

Symposium Profile: Graham Shirville, G3VZV

Joe Kornowski, KB6IGK
Editor
kb6igk@amsat.org

[Keith Baker, KB1SF/VA3KSF, photo.]

While on board the Carnival Liberty, I sat down with Graham Shirville, G3VZV. Recently chosen as the next president of the British Amateur Television Club (BATC), Graham also serves as editor of *OSCAR News* for AMSAT-UK, as well as a Region 1 Satellite Coordinator, for the International Amateur Radio Union.

According to the AMSAT-UK website, Graham has been closely involved in developing the ISS HamTV system and with schools contacts involving ESA astronaut Tim Peake's Principia Mission. A driving force behind AMSAT-UK's FUNcube satellite projects, he appeared working on the FUNcube-1 satellite in the RSGB Youth video, Amateur Radio – a 21st Century Hobby. He also provided the deployment mechanism for the Slow Scan Television satellite ARISSat-1/KEDR that was released from the International Space Station (ISS) by cosmonauts Sergei Volkov, RU3DIS, and Alexander Samokutyaev.

JK: What brought you into satellite operation as an amateur radio operator?
GS: Sputnik. I can't imagine why I was tuning the radiogram at the age of 9. But I was and I heard local amateur radio operators talking on … probably 40 meters AM and then tuned up and thought I could hear Sputnik 1.

JK: So what do you think it really was if it wasn't Sputnik 1?
GS: I don't know really. But that's where it started, and then I did all the things that young people do on radio and setting up a shack.

JK: When did you get your first license?
GS: On my fourteenth birthday. In those days, license exams were taken twice a year and one was on May 7, which happens to be my birthday.

JK: And so then how did you make the progression from early amateur licensee to satellite operator?
GS: I think the interest was always there. I suppose it had to wait until I got married and had a reasonable plot for some antennas.

JK: Okay, and so once you got involved, back in those days, what did you work and how did you work it?
GS: I was very fortunate because we had OSCAR-10 and OSCAR- 13 in those days OSCAR-10 was the first GTO [Geostationary Transfer Orbit] spacecraft, so long-range contacts were possible. And then OSCAR-13 was better, but unfortunately the perigee decayed and it didn't last very long. And then we all remember the OSCAR-40. But those days were really tremendous because we had such long-range communications for such a long time. And it was like having an 80-meter chat around the world.

JK: I could see where that would be exciting compared to some of today's LEO satellites.
GS: Well, it's different. You can get lots of fun by operating LEOs, getting lots of quick contacts and getting scores. But it's just different.

JK: What kind of equipment did you have back then?
GS: My 4CX250B linear amplifier was the thing I really loved. A real valve in a coaxial cavity and about 1.5 kilovolts – proper RF engineering.

JK: Now, why was that?
GS: Well, it produced at least 120 watts of RF and that was quite a lot in those days!

JK: And when did you join the AMSAT-UK Committee?
So, I became more involved with AMSAT-
GS: UK after Ron Broadbent, G3AAJ, who was the Secretary, passed away. Then, Jim Heck, G3WGM, and I got more involved with running it, or helping to run it. That was probably 10 or 12 years ago.
And we are also joint editors of OSCAR News.

JK: Okay, so tell me about how you came to be editor of OSCAR News.
GS: A big vacuum. Nature abhors a vacuum. Jim is also the Secretary of AMSAT-UK, and we do a double act. It works very well. We've now also got a new colleague, Frank Heritage, M0AEU, who is a graphics man and uses InDesign. So, you've seen the latest copy, and he is really moving it on. Full color magazine – usually 30+ pages available electronically or by post – please excuse the blatant plug for AMSAT-UK membership!

JK: And how do your ATV and satellite interests combine?
GS: There are two areas. One is the HamTV payload on the space station, which I first proposed to an ARISS meeting that took place at the University of Surrey 15 years ago. I was quite sensibly laughed out of court because I was proposing FM transmission, and the link budget just didn't make sense. And then, a few years later, we came back with a digital video proposal, and that's actually what we've got now. You know the Formula 1 racecars? Well, they've all got cameras everywhere now. But in those days, it was really brand new to have one camera whizzing past. And that was the same. That was DVB-S, with a relatively low symbol rate. A big question was, "could it track Doppler?" If you work out the relative speed of ISS to the ground station, and the Formula 1 car going past you at 200 miles an hour, they are about the same. In the end it took about 15 years to get HamTV going.

Of course the project needed the development of patch antennas for the outside of Columbus and the actual Ham video transmitter to be installed. So thanks to all the AMSAT and ARISS teams around the world that made it possible.

The most important part is that it really captures the kids' interests when they see Tim [Peake] up there. They say, "We've got you on video. Give us a wave, Tim!" And Tim is really elated as well.

JK: That was quite extraordinary. I saw the video.
GS: And that's fantastic because it gives a real connection.
JK: There's a context because it's not just a disembodied voice, like even a good FM radio connection.
GS: Yes, because we're used to a disembodied voice on a fairly crummy FM link. But the others in the audience are not. The audience is used to listening to high quality audio with no background hiss. And that's what you get with the audio from the S-band system. It is way ahead of VHF quality.

JK: And that raises another question that I think is interesting. Do you see that as the future of ARISS communications with ISS in particular?
GS: I think if we could get a HamTV system that is used regularly on the ISS that would greatly enhance the outreach. Whether that's possible to do, I don't know. It relies on ground stations, volunteers being available, and other volunteers having access to a few nice big dishes.

JK: Is it too outrageous to think that there could be satellite operation that is ground to ground via satellite HamTV at some point?
GS: No it is possible. There are plans for using the 1260MHz part of the patch antennas for uplinking.
Of course the other planned DATV link—and unfortunately this doesn't affect America — is the Es'Hail 2 geostationary spacecraft. This will have two linear transponders, S band up and X band down. One is 250 kHz wide for conventional CW/SSB activities and one that's 8 MHz wide that's planned for digital. So, we're going to have a third of the world covered with an amateur satellite carrying Digital ATV. How that's going to work nobody is yet quite sure. We know that it should work technically, but how is it going to be managed?

JK: How does that fit with your IARU duties and can you put that in context with what you're doing?
GS: Well, the IARU Satellite Coordination Panel, as you know, is primarily responsible for frequency coordination, trying to make sure we don't get two or more spacecraft in the same launch, or similar orbits, using the same frequencies. We've nearly had situations where the uplink and the downlink on different spacecraft have been the same. So, we've avoided that in the years that it's been going. I think we've done a pretty good job of avoiding the obvious gotchas.

The political side of it is difficult because there are so many players — the FCC, and experimental licenses, and normal amateur operations, and no pecuniary interest, and a whole lot of other jargon terms, which make it a complicated game to play. And, in the end, the reality is that the IARU has no power at all. It has influence but no power. And it's only the national regulator; in your case, the FCC has the power. And if the national regulator doesn't quite know what it's doing, or is working towards an agenda that is its own, then we have difficulties. We have also had a Chinese launch recently where we've had outputs on two meters in our amateur band, but not in the area of the two meter band which we, as IARU, band-plan for amateur satellite use.

JK: So, how does that relate to the things that Bob McGwier was talking about where he is moving into the digital realm where there will be time division and frequency division? How do you band-plan for that, or do you?
GS: Yes, well we don't do the band planning, at least we haven't up until now. That's an IARU responsibility, and requires the three regions of IARU to discuss and agree. Generally, of course, the three regions talk to each other, but not much in terms of VHF or microwave band planning, as historically it hasn't been necessary. The only things that need intercontinental band planning for VHF and microwave, or UHF and microwave, are EME and spacecraft operations. We've sort of lived without planning there up until now, but it is happening more.

JK: That sounds like an ambitious task.
GS: One of the things that's beginning to challenge us now is that generally we coordinate specific discrete frequencies, but now we're getting offered lots of CubeSat projects, where the teams are saying "we're frequency-agile. We can go wherever you want us to go. And we can be frequency agile after launch". And I don't know of many other satellite services where the equipment is capable of frequency change after launch. So, that's going to be quite new to consider how we deal with that and what the ITU thinks about it because the ITU regs go back to the days of crystal control
JK: When things weren't so flexible.
GS: The advantage for frequency coordination for the higher frequencies is that generally you've got a dish, so you're listening for a signal or transmitting a signal from discrete points in the sky. And the chances that you're going to have two amateur satellites on the same band or the same frequency in the same spot in the sky are fairly remote, I think. So, we've got geographical diversity as well as time diversity.

JK: So, what do you think about Elon Musk talking about Mars, and NASA is talking about Mars, and I don't know if ESA is also talking about it, but what's the future of space-based amateur radio when you're talking about those kinds of distances? Is that something anyone is talking about, thinking about, or it just a pie in the sky sort of thing?
GS: Have you seen the link budgets? I can't talk about Mars. I can talk about the Moon. In the US you have got the CQC [Cube Quest Challenge] and over in the UK we are putting a proposal together for a launch of what's called a Lunar Communications Pathfinder. This is a 500 kilogram spacecraft with attitude control, solar panels, lots of power, onboard propulsion — all the things that we say, "that's scary." It's going to deploy a number of CubeSats around the Moon and provide a communications hub for them whilst in orbit. So, that will deal with the link budget. And because it's going to be a fairly elliptical orbit, as I understand, it's going to be a long-term orbit. Apparently if you get into the right elliptical orbit, you don't crash. So, we're proposing a redundant communications system, which could do ranging and provide a transponder if you have a big enough ground station. And it would also either work with an omni-directional antenna in case of major failure, or we're also talking about putting an X band for downlink as well. All of those sorts of things are still being discussed, but one of the keys would be a very low data rate VHF transmission using, say, WSJT or JT65 or whatever — something like that. Not yet defined, but we think that the link budget will be such that whilst you won't be able to use a 2-meter turnstile like we do on FUNcube, a handheld Arrow in a playing field will get low data rate telemetry from the Moon.
JK: That would be astounding.
GS: Yes! It astounded us when we looked at some of the link budgets. I think it's about tens of watts of 2-meter power on the spacecraft, so not ridiculous amounts of power. But that doesn't get you to Mars.
JK: But it's a pretty big step. The idea of getting signals that are not EME but off a satellite that is in lunar orbit is fun.
GS: Listening to signals in a school that are from the Lunar orbit. If it's a clear day, you know where to point the aerial. Add to that ranging and we're ticking the boxes—interest for amateurs, interest for ESA, what they want as well, interest for school outreach, which they want as well — and not taking too much power.

JK: What about future astronauts? Tim Peake set the bar rather high, representing the U.K. very well.
GS: He's actually a British ESA astronaut. The process there is that ESA has a ministerial meeting every three years, which is coming up next month. The ministers agree which countries contribute to which of ESA's extra activities, and you have to put in a certain amount of money to ESA depending on per capita GDP. But then you can lock extra money in if you want to be involved with particular projects such as Mars explorer or human spaceflight or whatever. What we don't know is whether the U.K. is going to

carry on supporting human spaceflight for this next three-year period.

JK: So, who makes that decision? Is it Parliament?

GS: A U.K. minister I presume. But I'm nowhere near close enough to know what their views are. So, fingers crossed that they'll go, "Yes, we'll carry on funding it." Then the question is do they train another astronaut. But they haven't had another call. I think you've just had a call for more astronauts. I don't think ESA has recently. So, if we want another astronaut up there in the short term, I guess we send Tim back again because he knows the way in.

JK: Of course, that assumes he'd be amenable to doing that. But it sounds like he's the kind of guy who would be.

GS: Oh, Yes, he's always said he'd love to go back. The guys who selected him, they did a really good job.

JK: We need amateur satellites in higher Earth orbit. We have to get there. So, what do you see as the priority near-term goal?

GS: GTO, HEO. GTO is the nice one because it's not there all the time. You still have to turn your aerials as signals come and go. GEO in a way is like broadcasting. It's always there.

JK: Which could be a good thing.

GS: It's different. We've never had it before, so we don't know how it will be used.

JK: Meanwhile, we need more members. Well, we do. Do you?

Absolutely! Have you seen any kind of drop-off or flattening? What is the state of things?

GS: I saw some of your numbers at the board meeting, didn't I?

JK: You did.

GS: It's very similar. They're not going up enough. People just get so much information now over the Internet. Do they need us? Why should they join AMSAT? Yes, they become radio amateurs. They have to. We've got that built in. Does that mean I have to join AMSAT? What benefit do they see that they're getting?

JK: That's been the problem that every non-profit has faced — every membership organization.

GS: I don't have an answer for that. But ARISS activities at schools and the CubeSats in Universities are bringing in a new generation.

JK: As you suggest, bringing in the newer blood, the kids, is also a challenge.

GS: What we did for the ARISS contacts was, in almost every school, to get some kids together to take their foundation license. So, they were licensed radio amateurs. And the best one was selected to hold the microphone and make the call, which was a great idea from Ciaran, M0XTD. It took a lot of organization. Some were very good, some not so good, and some were brilliant. Jessica Leigh, M6LPJ, made the first contact at Sandringham school and later met Tim at Number 10 Downing Street. She is a superb ambassador for us as a young teenager.

JK: Any other challenges you see?

GS: Spectrum. Keeping the spectrum, as you were hearing yesterday. "Use or lose." There was a radio amateur, Jack Hum, G5UM (sadly now a silent key) — he was our VHF manager — but his mantra was also "use it or lose it." And everyone said, "Yes, Jack." But he was absolutely right. We are hearing about how the ARRL are now actively supporting these GEO projects to help protect the spectrum. For us in the UK, it's too late. We've lost lots of spectrum — lots at 10 GHz, lots at 3.4 GHz, lots at 2.4 GHz and we're just about to lose swathes of 5.6 GHz. I think we'll always keep a few narrow segments but not enough to operate the new digital modes, I fear. The good news is that, in the U.K., some additional VHF is becoming available to us. We have been lent an extra 1 MHz at 146-147 because in Europe we only have 144 to 146MHz. This is on the proviso that it's only used for experimental activity. So, we're developing digital TV that will fit in less than 1 MHz, This might also be suitable for other bands as well.

JK: Well, thank you. I appreciate your taking the time.

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AMSAT Annual Meeting

Barry Baines, WD4ASW
President
(Transcribed by Joe Kornowski, KB6IGK)

[Keith Baker, KB1SF/VA3KSF, photo.]

[Note: The following remarks accompanied a slide presentation that is available on amsat.org. — Ed.]

Board of Directors and Leadership Team

First of all, regarding our board, we have seven voting members of the board. We have two classes, four people for two years and three people for two years. The folks that just got elected to the class of 2018 were Tom Clark, Mark Hammond and Bruce Paige. The upcoming class, which will be up for reelection next year, is Jerry Buxton, Drew Glasbrenner, Bob McGwier and myself. And then the alternates voted every year. The alternates are the ones who didn't get enough votes to become voting members but are now regarded as being on standby. If something were to happen to one of our voting members, the first alternate would step up to voting status. And if we had two people who were unable to continue to serve, the second alternate would step up to a voting position as well.

These alternates are fully engaged with what we do. It's not required by the bylaws, but we ensure that every alternate is as fully engaged as they're willing to do. They're not obliged to do anything until they become a voting member to participate in conversations and

discussions and give their full input. They don't vote, but that way, if something were to happen, they're fully prepared to assume their voting responsibilities.

Unfortunately, in 2014, we lost two board members. One passed away; that was Tony [Monteiro], and then Gould Smith had to withdraw for medical issues. And so those alternates for that year became voting members.

The senior leadership team is elected by the board to serve one-year terms. And there's no change regarding the folks who are continuing in their positions. We have the same team as in 2016. The newest guy, if you will, is Paul Stoetzer, who is serving his second year now as corporate secretary. Regarding other key leaders, those are the ones who are appointed by the president. Joe Spier became our VP of Educational Relations last year. I'm announcing a new position. Gould Smith is coming back as Director of Field Operations. Other than that, the team is pretty much the same as in past years. Joe Kornowski has just completed his first year as AMSAT Editor and has done a fantastic job.

AMSAT's Mission and Vision

In terms of our mission statement and vision, this goes back to 2004. How we defined ourselves 12 years ago, or what is our purpose in life, is the same today. We did make a change in 2008 regarding our vision and satellite systems. Prior to that, were pushing HEO and, regarding reality, not being able to fly HEO satellites, we had to modify somewhat. But we talk about satellite systems, human space missions, and of course the LEOs. So, if you want to summarize it in a very succinct sentence — I use this all the time — the AMSAT purpose is to keep amateur radio in space. And how we've done that, it's different than how we did that 10 years ago or 20 years ago.

2016 Accomplishments/Issues

Let's go through some of the successes and also the issues in 2016. As you all heard this past weekend, some spacecraft are ready to fly. Fox-1Cliff and Fox-1 Delta are ready for launch. They are sitting in [VP of Engineering] Jerry's establishment in Grand Prairie, Texas. Vanderbilt applied for the CubeSat Launch Initiative (CSLI) in November 2015, and it was accepted in 2016 for Fox-1E or RadFxSat-2. We completed the P-4B payload accommodation study, as Bob [McGuire] mentioned yesterday. AMSAT invested $100,000 into that endeavor. Millennium Space Systems came back with an assessment that the amateur payload can be accommodated on the spacecraft and not impact the primary payload.

Most recently, RadFxSat-1/ Fox-1B went through environmental testing in Boxborough, Massachusetts. And they are going through their readiness review next month. One of the things we've learned from the Fox-1A program is involving partnerships — Virginia Tech, Vanderbilt, University of Iowa, three universities that we're collaborating with now. We're also collaborating with Ragnarok Industries on the Cube Quest Challenge. The bottom line is that the success of Fox is generating new relationships.

The Fox program continues to place materials in the public domain. One of the benefits of publishing the Symposium proceedings is to put those materials in the public domain so we can talk about it openly. The development of relationships on education continues. We've been working with ARRL on that. I know that Joe Spier wants to work with universities to push that forward.

The ARISS program has gone through some dramatic changes in the last couple of years regarding funding. And Frank Bauer, our VP of Human Spaceflight, has performed some real magic in term of getting funding from other sources within NASA. But now he's looking at sources outside of NASA to not only keep the program going from an operational point of view, but also coming up with the dollars that will be necessary to replenish the equipment that is onboard the space station. That's going to take real money, grants and the like.

Joe Kornowski with *The AMSAT Journal* took over the reins of the publication in January, and he's been doing stellar work. I hope everyone appreciates not only the quality of the publication you are being provided but also the fact that it's being provided within the issue date. We publish bi-monthly, so the second month is when you're receiving the magazine.

In terms of leadership changes, we have new members on the board who are replacing folks that decided not to run. JoAnne Maenpaa has decided not to run, but she's doing some things quietly behind the scenes for us. She's not fully retired from AMSAT, but she has to gauge her time very carefully so she's picking those things where she can make a difference very quickly.

Lou McFadin, being the glutton for punishment that he is, continues with the ARISS hardware program and doing the great work developing the systems that will replace current hardware on the space station. So, even though he's not serving on the board, he continues to do stellar work for us on the ARISS program.

Internet/IT technology modernization: Joe Fitzgerald is helping us with that. We lost Bob Carpenter, W3OTC, who was helping Martha at the AMSAT office. He was sort of a mini IT department helping her with some issues. But we've been able, with Joe's assistance, to come up with a process to get Martha the technical support that she needs when she needs it. And we continue to look at the modernization of what we offer — the internet and also what we can do to enhance our in-house technical capabilities and maintain the membership database and the like.

2017 Goals

In terms of 2017, we're looking at some launches. So, potentially we could have the Fox-1Cliff and 1D on Falcon 9 launch next year. There's been no announcement when launches will be resuming with SpaceX. We'll have Fox-1B with ELaNa-XIV, currently scheduled for March of next year. And we've been selected for the ELaNa-XX launch of the Fox-1E/RadFxSat-2. They're penciling right now December of 2017. Of course, launches have the propensity to run late, so we'll see if that materializes.

On the P-4B relationship with Virginia Tech, as I've mentioned, we've completed the payload accommodation study. There is some uncertainty about the status of the primary payload. So, at this point, we don't know what the pathway will be for that program. AMSAT is responsible for the Ground Terminal, submitting the IARU coordination papers, and managing the amateur radio payload once it is placed in service. So, we still have a finger in the pie in that respect. The participation for AMSAT was the $100,000 payment for the accommodation study. The remaining fundraising required for the completion of the payload and payment of the launch fee is Virginia Tech's fundraising responsibility. So, one of the things I look forward to regarding how that moves forward is that we, AMSAT, have to think about the future ourselves in terms of how we raise significant sums of money.

We'll be looking at two fundraising issues for us at the moment. One is ARISS, and how Frank does regarding raising funds for the ARISS program, and their capital

requirements, but also looking at what Bob and Virginia Tech can do for the P-4B project.

2017 Challenges

ARISS is operating under new relationships. We must continue to raise funds for both operational and capital needs. AMSAT and the ARRL are now fully engaged in dong the school selection process. Four years ago, NASA Education was selecting the schools. They have bowed out of that, and it's our responsibility now. We're putting out the announcements about the availability of time and deadlines for schools to submit their applications. Our people are the ones who are reviewing those applications, prioritizing them based on the quality of their input, and then making the final selections as to which schools will be given the opportunity for an upcoming school contact. So, the ARRL and we are fully engaged in that responsibility.

In terms of export control, you've heard for years about ITAR and the regulations regarding our involvement with foreign nationals. One of the benefits of Phase-4B is that whatever work is done involving AMSAT volunteers will be under the auspices of Virginia Tech's group of export security and research compliance to make sure that we follow the law. The transfer of communications satellites to EAR, Export Administration Regulations of the Department of Commerce, opens up opportunities for us to potentially work with other AMSAT organizations. We have not jumped into the technical details of how you abide by the EAR because there hasn't been an opportunity or requirement for us to do that. At some point down the road, should we put a proposal together where we might collaborate with another AMSAT organization, that's when we'll focus on trying to get up to speed on what the current rules and requirements are for compliance on export administration.

CubeSat licensing continues to be another issue of concern for us, for the IARU and for the League in terms of putting satellites into the amateur satellite service bands, whether they are amateur radio satellites or experimental licensed satellites. We are very much involved behind the scene in trying to orchestrate a solution in terms of how we might encourage universities and others to be amateur radio satellite qualified instead of following the experimental licensing route.

IT Future

Some of the things coming forward that, hopefully with Joe [Fitzgerald's] leadership, we can accomplish in the next year, include putting together a web-based membership platform where membership information will flow through a new process rather than what we have today. So, we'll be doing some modernization as we transition to a web-based process.

The AMSAT store needs upgrading. We've had some issues, as some of you are aware. And we'll be using third-party resources to come up with these solutions for us. We've come to a realization after trying for years to get volunteers to take on these tasks and if you have something that's mission critical that requires you to spend significant time to resolve, sometimes it is better to pay for that capability rather than try to get a volunteer to spend their off hours trying to work on a solution. So, we'll be spending a little money next year on IT as a result of that conclusion.

We're looking for content in all areas of where we have the ability to publicize what we do, or what our members are doing. We're soliciting materials for *The AMSAT Journal* and the AMSAT website. By the way, we're looking for a content manager to manage the website content. We're seeking content, expanding sources and sharing resources. The folks that publish are not necessarily the ones responsible for generating what is published. To the extent that people here can provide input — talk about your satellite experiences, work you've been involved with, lessons learned in terms of operating, whatever — we're looking for information all the time to be placed in these various resources.

Building Awareness and Support for AMSAT

One of the things we learned at the board meeting over the last few days is that the folks involved with our social media reach, receiving our Facebook pages or our tweets through Twitter, now outnumber our members. We have about 10,000 people who receive our tweets, and we've got about 3,500 who are on Facebook. So, the social media outlet is becoming a new expectation in terms of how people want to hear about us. The challenge for is how do you translate that interest in what we're doing, at least in terms of signing up to receive information, into support for AMSAT, whether in terms of AMSAT membership, or donations to our projects, or whatever. That's the challenge that we have. In terms of Field Operations, I'm very pleased that Gould Smith is now in position to come back onboard as a team leader for Field Operations and help us move forward in that arena

Membership Trends

As for membership trends, that is not a real good story. We continue to lose members. Our renewals are up, so the folks who join tend to renew, but overall the membership is going down. Part of that is because the biggest percentage of our membership is older, and some of them are starting to die off. And so, how do you bring in the next generation and rebuild the membership? We are hopeful that as we succeed with our launches — first, with AO-85 and moving on to launches in 2017 — interest in what we're doing will translate into the support of those wanting to join AMSAT. But it's a real challenge for us to build the membership. It's the membership that keeps the operational aspects of AMSAT going. It is what pays for the lights, for the office, for Martha's salary. It's what we have to pay for whether we're building satellites or not. To the extent that you can help recruit new members, their membership dues help support the underlying operating expenses of AMSAT.

Organizational/Financial Trends

To reiterate that, if you look at our budget, we're operating at a deficit. Not including satellite construction and design, with the cost to run the organization as it exists today, we are projecting a $147,000 deficit in 2017. And that's pretty significant. That does not mean that we're going to close the doors next year. But clearly, whenever you have deficits like that, you have to take those funds out of reserves. And those reserves are what keep us going from year to year when you have fluctuations in income and expenses. But it also takes money out of satellite projects, if it's a non-designated gift. If someone has said, "Use as you see fit," then it is possible that we will be in the position where we are taking money to keep the lights on when we want to use those funds to pay for satellites. So, growing the membership is critical, and so I ask you to help recruit new members.

Fundraising

It costs real dollars to have a presence in space, as we all know, and you want to keep the capital campaign separate from operating expenses. We're looking for ways to encourage donations. I always tell people that fundraising is a multi-year effort. If you are doing a capital campaign, you are going to do it for more than one year because you have to generate relatively large sums of money, and it takes years for us to complete a project. So, I ask people to think about us in terms of an annual pledge to AMSAT above and beyond your membership dues. Just like I give to my alma mater, I'll give to AMSAT just because they have a capital

campaign that needs my support. We also need to learn how to do a better job of campaigning. We may have a "teaching moment" if Virginia Tech is successful with their P-4B fundraising efforts.

I would point out one thing about capital donations is that major donors want to know that you are successful in what you want to do. And the success we've had regarding ARISSat-1 and now the Fox program — multiple launches, and the ARISS program overall — hopefully provides us with demonstrated ability to complete our projects, and that hopefully becomes the basis for convincing others that we are, indeed, worthy of their donations.

2017 Challenges: A View to the Future

Looking towards the future, of course, we are continuing to work with Virginia Tech, though we have uncertainty about the process of what's happening with P-4B. The engineering team is continuing to complete their projects and the launches of Fox-1D through 1E, but there is some focus on what we want to do next. Do we want to continue to move the Fox-1 program because there are universities out there that want to launch experiments? And every time we put one of those experiments on an OSCAR spacecraft, we keep providing more opportunities for amateurs to operate through satellites. But also we need to look forward. What are we going to do next? Related to that is enhancing the management team, and not just in engineering but in other areas. We are continually looking for new talent because we need to spread the workload around, and plan for the future in terms of who is going to run this organization down the road. Part of the timing is that we want to conduct a strategic planning process for AMSAT. The last time we did it was 2004 down in Orlando. We did a complete self-assessment of the organization. What are our strengths? What are our weaknesses? What are the opportunities that are out there? What are the threats? What has changed in the external environment that may influence what we want to do down the road? One of the major realizations that occurred a few years ago was that the cost of launches made what we had flown in the past no longer financially viable. It's been 12 years; we want to go ahead and do a review. Where do we want to be, where do we want to go, and how do we plan to get there?

Besides strengths and weaknesses of the organization, we want to assess where we are, what's important, what we must achieve, and who is accountable. And, of course, you are always reviewing, reviewing, reviewing. You don't sit still with what you want to do because the world around you will change the environment and undercut what you want to do.

We want to create a mission statement in this process, the current "who and what is AMSAT?" Then we want to create a vision statement: "What does AMSAT want to accomplish in the future?" What do we want to be in the next 5 to 20 years? So, it's appropriate for the board, which is responsible for the strategic direction of the organization, to take a serious look at where we are and conduct a self-assessment of where we want to go from here.

You come up with what you want to accomplish in the next 3, 4, 5, 6 years. How are you going to do that? One of the things you have to look at is what are the resources you must have to accomplish your goal? And of course, we have to find follow-up items, whether it is from the board, and the senior leadership and various departments, and look at how we are going to accomplish our goals and start achieving the vision we set for ourselves.

How AMSAT Members Can Help

I've already talked about recruitment. Recognize that satellite projects are multi-year projects that require multi-year financial support. By the way, we're still looking for donors for the launch campaign for Fox-1Cliff and Fox-1Delta. We made that commitment in 2014. We still have not received enough donations to offset the dollars we took out of the reserves to pay for that contract.

In the past year, AO-85 was placed in service along with the other existing satellites. Build awareness of what we're doing and get people to utilize the satellites. There's not a lot of activity from a wide number of people. There are some very active users, but it's not a broad base of satellite operators these days. Write materials for The AMSAT Journal and the other media outlets that we have. Find an area where your strengths and your interests can benefit AMSAT. If you identify that problem or opportunity, then step forward and help us resolve that problem. Don't just come to me or anybody else and identify a problem. I appreciate being advised, but we are looking for people to help us resolve that problem. If you see a weakness or an issue that's missing, help us to resolve that particular area of concern.

Determining the Most Common Satellite Azimuth from your QTH

Burns Fisher, W2BFJ

I recently moved to a new house with a fairly open yard, and of course one of my first tasks was to install my satellite antenna. I have a pair of beams that need to track the satellite that I am communicating with. However, I'm not good at climbing, so the roof or a tower is out. That means close to the ground, a location shared by my house. I had a lot of siting possibilities, but the choice criterion came down to "the antenna site with line of sight to satellites I care about blocked least often by my house." The question I must answer then is "at which azimuths do satellites spend most of their time when seen from my QTH?" I thought I knew the answer, but analysis is usually better than thoughts.

With ideas and help from Douglas, KA2UPW/5, Alan, WA4SCA, and Joe, KJ4JIO, I have come up with a series of steps to analyze the azimuth and elevation from any QTH of any satellite for which you have Keplerian elements, and then to plot the time it spends during the year in a given azimuth and elevation band. This article will give you the basics, and I will make an example Excel spreadsheet available at:
www.dropbox.com/s/ofwlve8vicyi943/AltAzAO85.xlsx?dl=0

I used a mixture of Linux predict and Excel for Macintosh. That was convenient for me, but it may not be for you. I encourage you to use my work as a base from which you make improvements to the process and the results.

Getting the Basic Data

There are many programs available for predicting satellite locations, but I needed one with an output that I could easily manipulate. I used KD2BD's PREDICT program. It is available easily for Ubuntu Linux—I just installed it using the normal "apt-get install" command. Read the help to determine how to specify your QTH coordinates and how to include the Keplerian elements of the satellites you are interested in.

When you can predict passes for the satellites you are interested in, you are ready for the next step.

The PREDICT program has some options, but the one I wanted was a list of azimuth

and elevation pairs from my QTH spaced a minute or so apart. Here is what I did (note that the exact value returned by the date command will differ depending on your time zone settings):

```
$ date --date="2016-1-1" +%s
1451624400
$ date --date="2017-1-1" +%s
1483246800
$ predict -f AO-85 1451624400
1483246800m -o Ao85year.txt
```

The "date" commands get the specified date and time in Unix format. Predict accepts these dates as start and end dates for the prediction. Note the "m" immediately after the second date. Adding "m" causes predict to output predictions at one-minute intervals rather than every second. Finally –o tells predict to put the output in the file named Ao85year.txt. You can certainly combine the "date" and "predict" commands into one line, but I have split them out to make it easier to read.

Table 1 shows a small sample of my Ao85year.txt (it will, of course, vary depending on your QTH and which satellite you are predicting). The first two numeric columns are of interest to us: the elevation and azimuth. One thing to notice immediately is that in this mode, predict does not just list visible passes, but includes the satellite's location for every minute, even when it is below the horizon (negative elevation). We will deal with that later.

I specified a full year of predictions since I know that satellite visibility changes through the year. This method is not the best choice since Keplerian elements get stale in less time than one year.

Analysis of the Basic Data

At this point, I took the Ao85year.txt file from Linux to a Macintosh running Microsoft Excel. Windows should work equally well. A DOS version of PREDICT may run on Windows, and of course, there are spreadsheet programs (such as Libre Office Calc) in Linux, but I happened to use what I knew best.

Our goals are as follows:

1) Eliminate times when the satellite is not visible
2) Divide the data into elevation bands
3) Count the number of minutes during the time period that the satellite is visible and
4) Plot the number of minutes that the satellite is visible at various azimuths and elevations.

First, import the text file into Excel specifying that the columns are separated by spaces. I suggest that each time you import a file, you put it on a different page in the same worksheet. Then you can choose the source page you want to run calculations on. I imported only the first four columns, and then sorted the columns on the elevation, and removed the negative values (which are now all at one end). The result looks something like table 2 (but with thousands of rows).

Notice that the date columns are not necessary; I just found it comforting to see them rather than only random numbers.

The next step is to create a new page for the calculations. On this page, you first make a table where each row represents one of the rows in your raw data (remember there are thousands!), and each column showing an elevation range (0-10, 10-20, etc.). The cells contain a formula that leaves either an invalid number or the azimuth from the matching source row. An example is shown in Table 3.

Here is the formula in each of these cells (this is for cell E67):

=IF(AND(SourceData!$E67>=E$2,SourceData!$E67<E$3),SourceData!$E67,1000)

where E$2 and E$3 are the azimuth ranges for this column and SourceData!$E67 is the cell on the source page holding the data for this row.

In words, this formula says, "If the matching source data is between the elevations shown in row 2 and 3, put the source data in the cell, otherwise put 1000." Now each valid number indicates one minute where the satellite was visible. The column containing the number indicates its altitude, and the valid number is its azimuth.

Now FINALLY, we get to count the number of minutes spent in a particular azimuth range using a different and much smaller section of the spreadsheet. We do this by using the Excel function FREQUENCY in a new section of the spreadsheet that is 12 columns wide by 36 rows high. The section looks like Table 4. You must have the column with azimuth values (column L in the figure) since that is used by the FREQUENCY function. The other column shows the number of seconds during the year where the satellite is visible at a particular elevation and azimuth range. (You can add a column for all elevations as I did if you wish.)

The formula for column N is:

=FREQUENCY(B$5:B$34525,L5:

1451659260	Fri 01Jan16 14:41:00	-11	314	218	-25	95	4214	-139 *
1451659320	Fri 01Jan16 14:42:00	-8	314	221	-28	93	3809	-139 *
1451659380	Fri 01Jan16 14:43:00	-5	313	223	-31	91	3402	-139 *
1451659440	Fri 01Jan16 14:44:00	-2	313	226	-35	89	2992	-139 *
1451659500	Fri 01Jan16 14:45:00	1	313	229	-38	87	2580	-139 *
1451659560	Fri 01Jan16 14:46:00	5	312	231	-41	85	2169	-139 *
1451659620	Fri 01Jan16 14:47:00	11	311	234	-44	82	1762	-139 *
1451659680	Fri 01Jan16 14:47:59	18	310	236	-47	79	1362	-139 *
1451659740	Fri 01Jan16 14:49:00	30	309	239	-50	76	984	-139 *
1451659800	Fri 01Jan16 14:50:00	52	304	242	-53	72	668	-139 *
1451659860	Fri 01Jan16 14:51:00	82	191	244	-56	67	542	-139 *
1451659920	Fri 01Jan16 14:52:00	47	140	247	-58	62	713	-139 *
1451659980	Fri 01Jan16 14:53:00	27	136	250	-60	56	1045	-139 *
1451660040	Fri 01Jan16 14:54:00	16	135	252	-62	49	1428	-139 *
1451660100	Fri 01Jan16 14:55:00	9	134	255	-63	42	1831	-139 *
1451660160	Fri 01Jan16 14:55:59	4	133	1	-64	34	2240	-139 *
1451660220	Fri 01Jan16 14:57:00	0	133	4	-65	25	2652	-139 *
1451660280	Fri 01Jan16 14:58:00	-3	132	7	-65	17	3065	-139 *
1451660340	Fri 01Jan16 14:59:00	-6	132	9	-64	8	3476	-139 *
1451660400	Fri 01Jan16 15:00:00	-9	131	12	-63	0	3884	-139 *

Table 1.

Source Data from Predict Program

Unix Date	Date	Elev	Az
1456786320	Mon 29Feb16 22:52:00	89	352
1480136280	Sat 26Nov16 04:58:00	88	301
1468748760	Sun 17Jul16 09:46:00	87	39

Table 2.

	B	C	D	E	F	G	H	I	J
1	Azimuth at different Altitude Ranges (1000=not valid)								
2	0	10	20	30	40	50	60	70	80
3	10	20	30	40	50	60	70	80	90
4									
5	1000	1000	1000	1000	1000	1000	1000	1000	352
6	1000	1000	1000	1000	1000	1000	1000	1000	301
7	1000	1000	1000	1000	1000	1000	1000	1000	39
8	1000	1000	1000	1000	1000	1000	1000	1000	217
9	1000	1000	1000	1000	1000	1000	1000	1000	45
10	1000	1000	1000	1000	1000	1000	1000	1000	218
11	1000	1000	1000	1000	1000	1000	1000	97	1000
12	1000	1000	1000	1000	1000	1000	1000	11	1000
13	1000	1000	1000	1000	1000	1000	1000	199	1000
14	1000	1000	1000	1000	1000	1000	1000	214	1000
15	1000	1000	1000	1000	1000	1000	1000	233	1000

Table 3.

L40)

The FREQUENCY function counts the number of times in the range specified by its first argument (B$5:B$34525) that the numbers between the values in its second argument range appear. The output is an array extending down the column, so you must use care to get the output to appear in the column below the FREQUENCY function. Check Google for how to do this with your Excel version and operating system. The next column will specify as input C$5:C$34525 and the third column D$5:D$34525, etc. Cells with "1000" in them are never counted because the values in the second argument range never go up that high. My result is shown in Table 4.

Finally, you can easily make a chart to display everything more clearly. Just select the rectangle of numbers we just created and specify a 2D line chart. Figure 1 and 2 show some examples for a couple of different QTHs using AO-85 as the satellite:

Figure 1 represents my QTH in FN42. It may be similar to that for many of us in the northern United States and southern Canada. Clearly, the bird spends much more time at low altitudes than high (but we knew that) and the best visibility is most commonly in an arc centered around north. The width of the arc is of interest: the least likely visibility locations are from around 90 degrees to 270. So you could say that the entire northern half of the sky is better than the entire southern half of the sky, and if you can place your antenna so the shadow is centered on the south, that is optimal for AO-85. You should check other satellites that you frequently use as well.

Now look at figure 2 plotting a different set of data made for a hypothetical QTH in Patagonia (the southern part of South America). Notice that for low elevations we get a strong dip due south, while for higher elevations the peak is south. I hypothesize this means that at low elevations in Patagonia, one is looking south of the southern most point of AO-85's orbit at all times during the year. Notice that there is a similar but less pronounced dip due north from the northern QTH.

L	M	N	O	P	Q	R	S	T	U	V
Azimuth	Seconds Per Year All Altitudes	0-10 Degrees	10-20 Degre	20-30 Degre	30-40 Degre	40-50 Degre	50-60 Degre	60-70 Degre	70-80 Degre	80-90 Degrees Altitude
10	1758	1133	366	144	57	25	19	8	5	1
20	1951	1359	360	122	54	27	14	11	1	3
30	1914	1368	322	117	54	25	14	13	0	1
40	1365	888	271	112	43	27	10	10	3	1
50	1149	680	263	103	57	29	9	4	4	0
60	1015	574	242	103	45	22	15	6	4	4
70	898	500	213	87	40	27	19	7	5	0
80	827	435	204	93	53	16	13	8	3	2
90	759	389	196	83	39	21	15	10	4	2
100	731	383	179	80	41	24	7	10	7	0
110	666	347	155	80	39	21	18	4	1	1
120	652	341	154	80	35	16	8	13	5	0
130	629	321	148	79	38	24	10	5	3	1
140	609	308	154	72	29	25	15	4	2	0
150	614	314	150	72	39	17	10	8	4	0
160	590	294	144	67	43	17	13	3	8	1
170	582	301	137	70	28	21	15	7	3	0
180	602	305	145	66	41	21	10	7	4	3
190	577	295	133	69	39	17	13	7	4	0
200	598	309	142	64	35	20	14	8	3	3
210	586	293	138	73	39	20	13	3	6	1
220	610	306	154	74	35	17	12	10	1	1
230	595	301	148	73	35	15	13	4	4	2
240	637	321	161	71	37	25	11	8	2	1
250	637	331	149	74	39	20	16	5	2	1
260	696	360	170	83	40	18	16	4	4	1
270	713	375	173	76	45	18	13	5	7	1
280	767	398	191	91	37	22	12	9	5	2
290	837	447	198	85	51	27	13	8	7	1
300	914	518	213	93	43	19	14	7	5	2
310	1019	569	243	108	43	27	14	9	4	2
320	1186	714	268	101	48	28	14	5	3	5
330	1412	904	281	114	56	25	15	8	7	2
340	1959	1423	315	121	56	22	16	5	1	0
350	1873	1297	352	117	56	27	16	5	3	0
360	1594	1023	356	114	52	23	13	9	4	0

Table 4.

Improvements

One can make some improvements to this analysis. The first obvious one is that the Keplerian elements I used were stale for part of the year. You can instead collect the altitude and azimuth predictions only a month at a time based on a set of Keplerian elements that were new at the time you are predicting.

Another improvement is to limit the altitude displayed to what you are interested in. For example, if you are in a valley, you may care only about passes above 10 or even 20 degrees. If you remove the 0-10 degree column, the graph will be scaled to show the higher elevations better.

Finally, if you are going to do this often, you probably want to automate the process more. Excel experts might be able to establish data connections to the source, for example.

While mathematical analysis often proves intuition wrong, I still encourage you to examine graphs like these, especially for your QTH, to ensure that they make sense. You can also use them in an attempt to get an empirical feel for how orbits work. As part of this effort, you might try some other interesting locations: the equator, north or south poles, a point under the north-most or south-most point of a satellite's orbit for example. Also try different satellites in very different orbits: The ISS, AO-85, AO-7 and a GPS satellite, for example.

Conclusion

Using the spreadsheet described here, I found a location near my house where the house blocked mainly views to the south. After a lot of hole digging and ground rod driving, I ended up with the setup in Figure 3, which seems to give me a lot of AO-85 visibility during a pass and which I can access with only a stepladder.

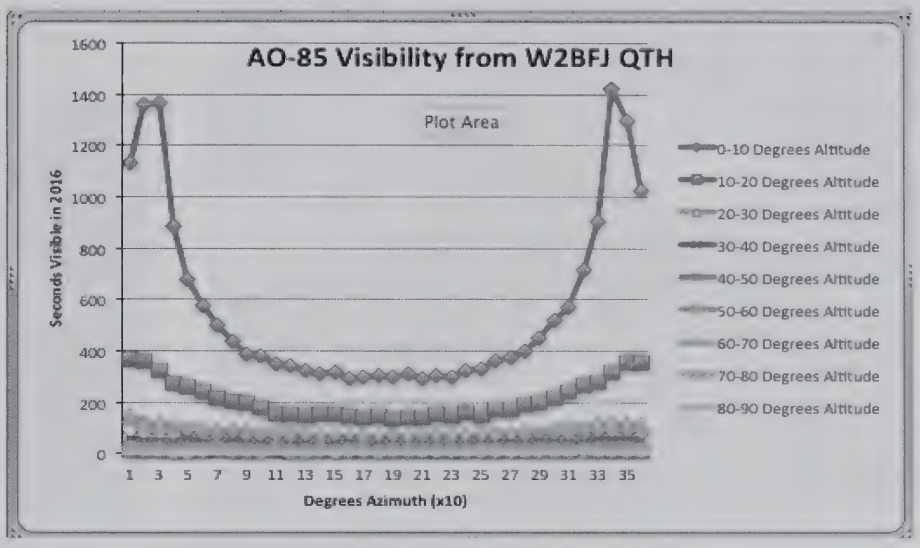


Figure 1.

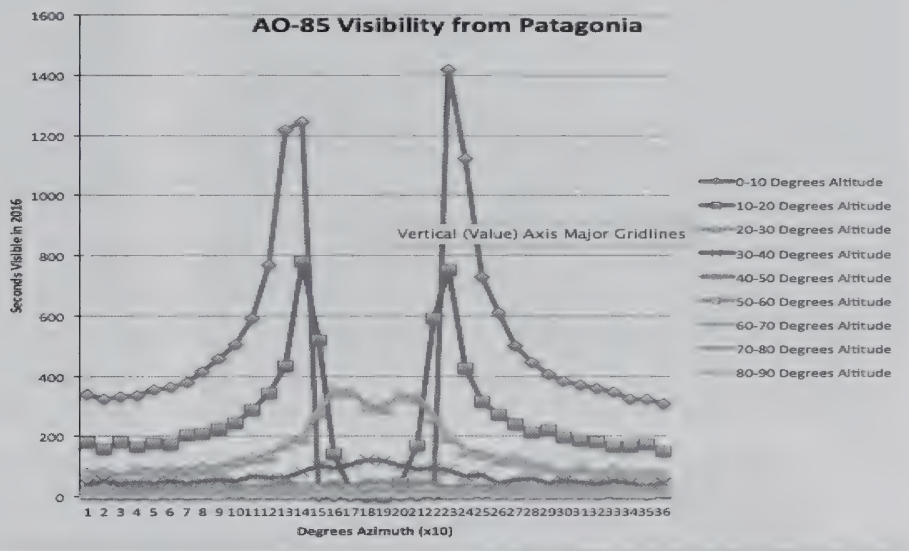


Figure 2.

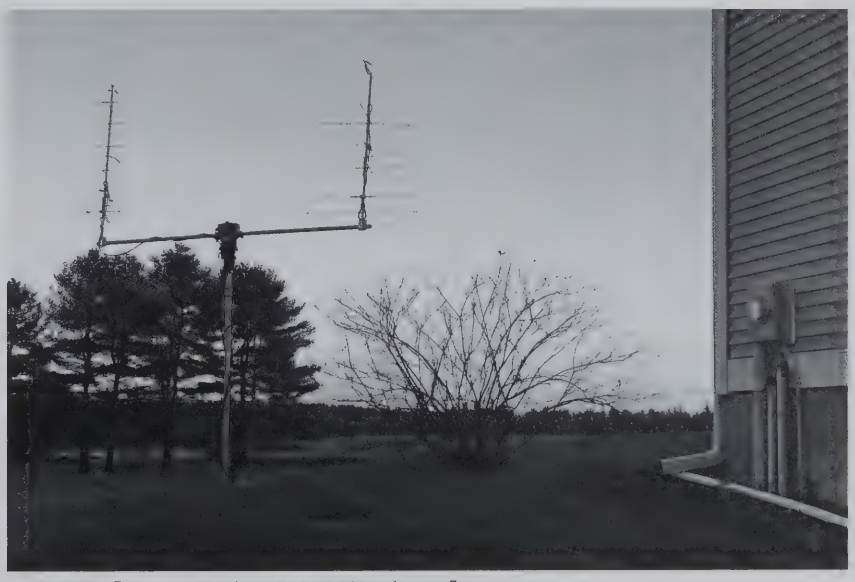


Figure 3. [Burns Fisher, W2BFJ, photo.]

The Board Meeting

DoubleTree at Galveston Beach. [Keith Baker, KB1SF/VA3KSF, photo.]

The Gulf from the hotel. [Keith Baker, KB1SF/VA3KSF, photo.]

Barry Baines, WD4ASW. [Sharon McGwier, N1SMM, photo.]

Clayton Colemen, W5PFG, Paul Stoetzer, N8HM, Joe Kornowski, KB6IGK, Jerry Buxton, N0JY. [Sharon McGwier, N1SMM, photo.]

AMSAT Board of Directors. [Keith Baker, KB1SF/VA3KSF, photo.]

View forward at dusk. [Keith Baker, KB1SF/VA3KSF, photo.]

Cabin with balcony. [Keith Baker, KB1SF/VA3KSF, photo.]

View towards stern, top deck. [Keith Baker, KB1SF/VA3KSF, photo.]

Carnival Fantasy docked next to Carnival Liberty at Progreso, Mexico. [Keith Baker, KB1SF/VA3KSF, photo.]

Carnival Liberty at Progreso, Mexico. [Keith Baker, KB1SF/VA3KSF, photo.]

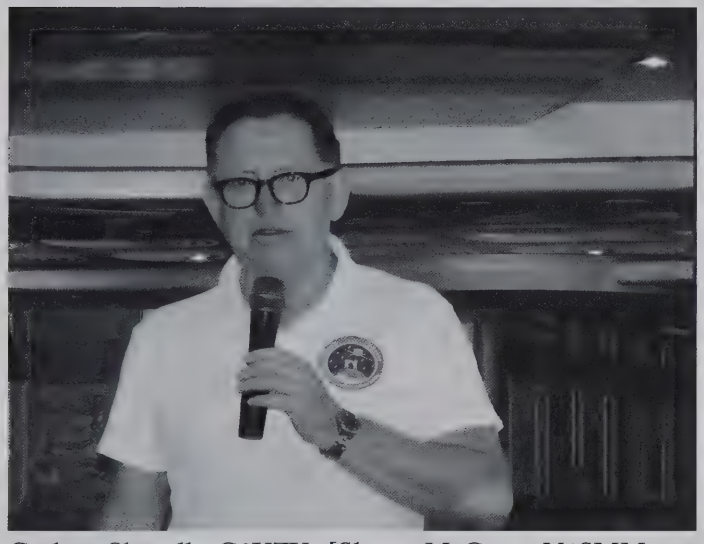
Barry (WD4ASW) and Kathy (WD4ASX) Baines. [Keith Baker, KB1SF/VA3KSF, photo.]

Progreso, Mexico, ships in background. [Keith Baker, KB1SF/VA3KSF, photo.]

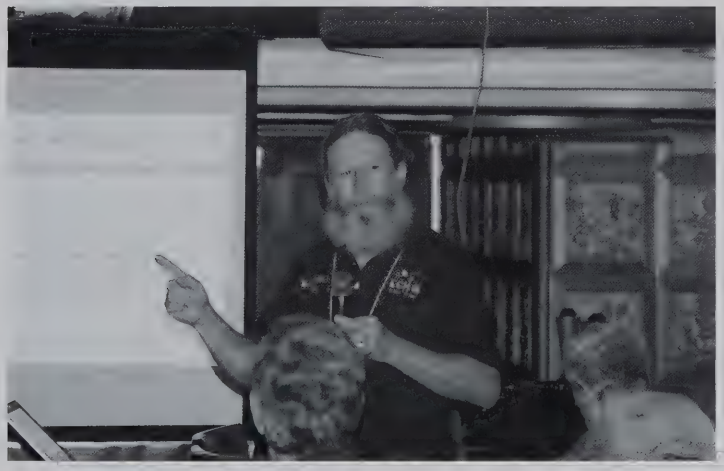
Michael Lipp, HB9WDF, and Peter Guelzow, DB2OS. [Keith Baker, KB1SF/VA3KSF, photo.]

Bob McGwier, N4HY. [Sharon McGwier, N1SMM, photo.]

Members gather for AMSAT Annual Meeting onboard Carnival Liberty. [Sharon McGwier, N1SMM, photo.]



Graham Shirville, G3VZV. [Sharon McGwier, N1SMM, photo.]



VP Educational Relations, Joe Spier, K6WAO. [Keith Baker, KB1SF/VA3KSF, photo.]

Clayton Coleman, W5PFG, Chair of the Symposium Committee. [Keith Baker, KB1SF/VA3KSF, photo.]

Clayton Coleman, W5PFG. [Sharon McGwier, N1SMM, photo.]

Paul Stoetzer, N8HM, and Keith Baker, KB1SF/VA3KSF. [Sharon McGwier, N1SMM, photo.]

Wyatt Dirks, AC0RA. [Keith Baker, KB1SF/VA3KSF, photo.]

Pedro (CU2ZG, at right) from HM77 in The Azores traveled the 3,827 miles to hand deliver his QSL card from his AO7 contact with George (WA5KBH) in EM30 ... per George.

Graham, G3VZV, demonstrating deck chair antenna mount. [Sharon McGwier, N1SMM, photo.]

Frank Westphal, K6FW, and Bob Hinshaw, N6UK. [Keith Baker, KB1SF/VA3KSF, photo.]

Randy Berger, WA0D, and his wife. [Sharon McGwier, N1SMM, photo.]

Strategizing the bird hunt. [Sharon McGwier, N1SMM, photo.]

The slings and "Arrows" of competitive satellite chasing. [Keith Baker, KB1SF/VA3KSF, photo.]

Recognition and Thanks to Our Dedicated Volunteers in 2016

Presidential Recognition

Frank Bauer, KA3HDO

In Presidential Recognition of Your Contributions to the AMSAT Mission

Thank you for your continued strong leadership of ARISS and ARISS-I. You have secured funding from outside sources to keep ARISS operational in 2016 and into 2017. You've enhanced the level of collaboration with ARISS's US partners CASIS and SCAN and developed a strategic plan for ARISS that identifies key strengths and viable goals for continued growth and enhancement of the program. ARISS-I continues to evolve as well. Under your leadership, you've expanded the level of communication and coordination internationally, laying the foundation for the future of amateur radio on the ISS. Your dedication and passion for ARISS continue to inspire those with whom you work.

Steve Belter, N9IP

In Presidential Recognition of Your Contributions to the AMSAT Mission

Thank you for your continued stewardship of AMSAT's presence at the Dayton Hamvention, helping to spread the AMSAT story and raising funds for AMSAT's continued operation. Your leadership of AMSAT at amateur radio's largest venue is reflected by your attention to detail and ability to recruit and retain key volunteers. Your imaginative enhancements to AMSAT's physical presence at Hamvention resulted in increased recognition for AMSAT. Your direct involvement in the expansion of content found in Gould Smith's Getting Started with Amateur Satellites, including conversion to a color edition that you made possible by your finding a suitable printer at reasonable cost, has resulted in setting new levels of quality and value of the book as a resource to the amateur satellite operator community.

Joseph Kornowski, KB6IGK

In Presidential Recognition of Your Contributions to the AMSAT Mission

Thank you for stepping forward to assume leadership of the AMSAT Journal effective with the January/February 2016 issue. That publication is considered to be the key benefit of AMSAT membership. Your creation of an Editorial Style Guide, coupled with finding ways to enhance content management as well as meeting publication schedules to ensure timely availability of each issue, are examples of how you've instilled new levels of energy in the creation of each issue.

Jerry Buxton, N0JY

In Presidential Recognition of Your Contributions to the AMSAT Mission

Thank you for your outstanding engineering leadership that has resulted in the successful placement in service of AO-85 and prepared Fox-1Cliff and Fox-D for launch in the near future as well as the upcoming RadFxSat/Fox 1-B launch. Along with managing a successful engineering team for the Fox-1 program, you've established relationships with universities that have resulted in new opportunities for flying the Fox-1 design, including Fox-1E that has been accepted by NASA as well as adapting the Fox-1 communications package for use by universities in their own projects. Meanwhile, you have shepherded current efforts to develop 5 GHz/10 GHz a ground terminal design adaptable for the CubeSat Challenge, a potential Phase 4-B payload, and eventual development of a HEO 6U CubeSat as well as collaborated with Ragnorak to provide a communications package. Your leadership by example has inspired the engineering team and your countless man-hours focused on completing the Fox-1 series projects is deeply appreciated.

Peter Portanova, W2JV

In Presidential Recognition of Your Contributions to the AMSAT Mission

Thank you for representing AMSAT to a key major donor that resulted in the receipt of a significant contribution in support of AMSAT's engineering programs. Your willingness to serve as a key point of contact was handled through a variety of ways, including personal interaction as well as serving as a conduit that provided key technical support in response to the donor's queries and areas of interest. Your ability to discretely handle the relationship and focus on closing the request was instrumental in securing a level of support that exceeded AMSAT's past experiences in securing donations.

Andrew Glasbrenner, KO4MA

In Presidential Recognition of Your Contributions to the AMSAT Mission

Thank you for managing our relationship with Spaceflight, Inc. in support of Fox-1Cliff and Fox-1D. In addition, you've handled AMSAT's social media presence as well as continued to support the adoption of current generation methods through PayPal. Your representation of AMSAT-NA and presentation on our projects at the 2016 AMSAT-UK Colloquium is also appreciated.

Bruce Paige, KK5DO

In Presidential Recognition of Your Contributions to the AMSAT Mission

Thank you for your continuing management of AMSAT's Awards Program. The issuing of certificates coupled with review of submissions to ensure that each submission fully qualifies takes time and attention to detail. In addition, your support of the AMSAT Store has improved how it reflects our product offerings. Your willingness to take on such background tasks is appreciated.

Paul Stoetzer, N8HM

In Presidential Recognition of Your Contributions to the AMSAT Mission

Thank you for the variety of ways that you have enhanced AMSAT's ability to reach out to both the AMSAT membership and the amateur radio community in general. Along with fulfilling your duties and responsibilities as Corporate Secretary, including the handling of the 2016 Board of Directors election and the drafting of minutes for AMSAT Board Meetings, you've also provided valuable support for the AMSAT Office by helping Martha with various office tasks. Thanks, too, for your organization and operation of the live AMSAT demonstrations at the Dayton Hamvention. Thank you for your active presence on the AMSAT-BB, your regular contributions to the AMSAT Journal, and your constant updates to the AMSAT website. These help keep our members informed with accurate information. Your willingness to lend a hand when needed is deeply appreciated.

Engineering

Steve Conklin, AI4QR

In Recognition of Your Outstanding

Contributions to AMSAT Engineering

Thank you for your work on AMSAT Ground Terminal. This included leading the effort to complete the first web app for it and presenting at DEFCON Wireless Village on behalf of AMSAT Ground Terminal. Thank you, as well, for leading the effort to design an AMSAT Ground Terminal badge that interacts with, promotes, and expands the AMSAT Ground Terminal radio system. In addition, thank you for winning AMSAT Ground Terminal a LimeSDR through the LimeSDR design contest. Finally, thank you for providing substantial design review, GitHub support, and VITA-49 draft standards documents, in addition to serving as Linux platform lead for AMSAT Ground Terminal.

Bob Davis, KF4KSS

In Recognition of Your Outstanding Contributions to AMSAT Engineering

Thank you for your countless hours of effort in mechanical engineering, ranging from solar cell procurement to constantly moving test date targets and changing deliverables for environmental testing, allowing the successful completion of Fox-1Cliff, Fox-1D, and RadFxSat

Howie DeFelice, AB2S

In Recognition of Your Outstanding Contributions to AMSAT Engineering

Thank you for your countless hours of heading the Phase 5 CQC project, interfacing with Ragnarok Industries and the other systems teams, pursuing the IARU coordination, and helping to keep Phase 5 CQC in the running to be AMSAT's first Phase 5 satellite

Ron Economos, W6RZ

In Recognition of Your Outstanding Contributions to AMSAT Engineering

Thank you for providing expert consulting advice by evaluating the SiLabs chipset using the SiLabs evaluation module, and for completing, publishing and testing the VL-NR GNURadio blocks for DVB-S2X for all to use

Burns Fisher, W2BFJ

In Recognition of Your Outstanding Contributions to AMSAT Engineering

Thank you for your extraordinary contributions to the troubleshooting and resulting software fix of Fox-1Cliff at environmental testing

Marc Franco, N2UO

In Recognition of Your Outstanding Contributions to AMSAT Engineering

Thank you for your extraordinary contributions to the quick troubleshooting and repair of the RadFxSat receiver.

Norm Fusaro W3IZ Operations

In Recognition of Your Outstanding Contribution to AMSAT Operations

Thank you for your role in creating and supporting the ARRL National Parks on the Air event. This event has provided amateur satellite operators throughout North America with many hours of fun and excitement throughout 2016.

Dan Habecker, W9EQ

In Recognition of Your Outstanding Contributions to AMSAT Engineering

Thank you for your extraordinary contributions to the quick troubleshooting and repair of the RadFxSat receiver.

Steve Hicks, N5AC

In Recognition of Your Outstanding Contributions to AMSAT Engineering

Thank you for your significant ongoing contributions to the air interface standard, for providing enormous opportunities with Flex Radio by publicly backing the AMSAT Ground Terminal Project, and for supporting the potential manufacturing of a Phase 4 Ground radio. Thank you, as well, for obtaining the loan, at no cost, to AMSAT of the SiLabs DVB chipset evaluation module, allowing us to carry out a variety of tests essential to AMSAT Ground Terminal component engineering and GNURadio block verification.

Damon Wascom, KC5CQW

In Recognition of Your Outstanding Contributions to AMSAT Engineering

Thank you for tireless efforts in assembling the systems of the Fox-1 satellites in the face of short timelines.

Melanie Wascom, KF5TNK

In Recognition of Your Outstanding Contributions to AMSAT Engineering

Thank you for tireless efforts in assembling the systems of the Fox-1 satellites in the face of short timelines.

Paul Williamson, KB5MU

In Recognition of Your Outstanding Contributions to AMSAT Engineering

Thank you for your significant ongoing contributions to the air interface standard, your presentation at DEFCON Wireless Village on behalf of AMSAT Ground Terminal. Thank you as well for your fundamental contributions in the Flex Radio cooperation and support discussions, and your evaluations of numerous candidate platforms, protocols, standards, and equipment.

Michelle Thompson, W5NYV

In Recognition of Your Outstanding Contributions to AMSAT Engineering

Thank you for tireless effort driving the AMSAT Ground Terminal in attracting volunteers, keeping the project in the public eye, dealing with vendors to supply equipment, and inspiring the AMSAT Ground Terminal team members to move forward with innovative ideas.

Bill Reed, NX5R

In Recognition of Your Outstanding Contributions to AMSAT Engineering

Thank you for conceiving and driving the ASCENT SDR Development Team to provide AMSAT expertise in FPGA programming and to develop a flexible SDR suitable for varied AMSAT missions.

Eric Skoog, K1TVV

In Recognition of Your Outstanding Contributions to AMSAT Engineering

Thank you for your involvement with the systems engineering of RadFxSat and RadFxSat-2, which quickly and expertly filled a void and led to the rapid development of the Fox-1E linear transponder.

Operations

Lee Imber, WW2DX

In Recognition of Your Outstanding Contribution to AMSAT Operations

Thank you for your outstanding efforts activating St. Paul Island on the amateur satellites during the CY9C DXpedition.

Patrick Dolan, N2IEN

In Recognition of Your Outstanding Contribution to AMSAT Operations

Thank you for your outstanding efforts activating St. Paul Island on the amateur satellites during the CY9C DXpedition.

Sean Kutzko, KX9X

In Recognition of Your Outstanding Contribution to AMSAT Operations

Thank you for your role in creating and supporting the ARRL National Parks on the Air event. This event has provided amateur satellite operators throughout North America with many hours of fun and excitement throughout 2016.

User Services

Alan Biddle, WA4SCA

In Recognition of Your Outstanding Contributions to AMSAT User Services

Thank you for your work to revise and update Gould Smith's Getting Started With Amateur Satellites. This book is AMSAT's best guide to operating the amateur satellites for newcomers to our hobby.

Chuck Pinkham, K3PER

In Recognition of Your Outstanding Contributions to AMSAT User Services

Thank you for being an essential part of AMSAT's presence at the Dayton Hamvention. Your continuous involvement before, during, and after the Hamvention facilitated the presentation of the AMSAT story to the wider amateur radio community.

Douglas Quagliana, KA2UPW

In Recognition of Your Outstanding Contributions to AMSAT User Services

Thank you for your hard work as an Assistant Editor of *The AMSAT Journal*. The importance of that publication is a key benefit of AMSAT membership. This is reflected in your support of the content, which presents key advances in technology and operations, and highlights the achievements of the organization. Your editorship and close support of the content and appearance of the articles improves the quality of the *Journal*.

Gould Smith, WA4SXM

In Recognition of Your Outstanding Contributions to AMSAT User Services

Thank you for your active participation in AMSAT's presence at the Dayton Hamvention. Thank you as well for your authorship and contribution of the book Getting Started With Amateur Satellites.

Phil Smith, W1EME

In Recognition of Your Outstanding Contributions to AMSAT User Services

Thank you for being an essential part of AMSAT's presence at the Dayton Hamvention. Your contribution during the Hamvention along with your enthusiasm for our hobby has contributed directly to AMSAT's successful participation in the Dayton Hamvention.

Bernhard Jatzeck, VA6BMJ

In Recognition of Your Outstanding Contributions to AMSAT User Services

Thank you for your hard work as an Assistant Editor of *The AMSAT Journal*. The importance of that publication is a key benefit of AMSAT membership. This is reflected in your support of the content, which presents key advances in technology and operations, and highlights the achievements of the organization. Your editorship and close support of the authors of featured technical articles improves the quality of the *Journal*.

Steve Kenwolf, WH6BSZ

In Recognition of Your Outstanding Contributions to AMSAT User Services

Thank you for your imaginative and professional designs that have graced the AMSAT shirts and hats, as well as the banners and posters used at the Dayton Hamvention.

John Kludt, K4SQC

In Recognition of Your Outstanding Contributions to AMSAT operations
Thank you for representing AMSAT and ARISS at amateur radio events in the Atlanta area as well as making presentations at the 2016 ARRL Southeastern Division Convention at Huntsville, AL in August and the 2016 North Carolina State ARRL Convention at Shelby, NC in September. In addition, you've had a presence at the Makers Faires in the Atlanta area highlighting amateur radio in general and amateur radio in space in particular. Your willingness to make these presentations has enhanced awareness of amateur radio in space and helped to build interest in AMSAT and ARISS.

Stefan Wagener, VE4NSA

In Recognition of Your Outstanding Contributions to AMSAT User Services

Thank you for being an essential part of AMSAT's presence at the Dayton Hamvention. Your contribution during the Hamvention along with your enthusiasm for our hobby has contributed directly to AMSAT's successful participation in the Dayton Hamvention.

W. M. "Red" Willoughby, KC4LE

In Recognition of Your Outstanding Contributions to AMSAT User Services

Thank you for your hard work as an Assistant Editor of *The AMSAT Journal*. The importance of that publication is a key benefit of AMSAT membership. This is reflected in your support of the content, which presents key advances in technology and operations, and highlights the achievements of the organization. Your editorship and close support of the content and appearance of the articles improves the quality of the *Journal*.

Mike Young, WB8CXO

In Recognition of Your Outstanding Contributions to AMSAT User Services

Thank you for building and testing the LVB Trackers that we sell at the Dayton Hamvention and through the AMSAT Store. Your effort results in a significant source of income for AMSAT.

Symposium

Allen Mattis, N5AFV

In Recognition of Your Outstanding Support of the 2016 AMSAT Space Symposium and Inspiration for the Cruise.

Glenn Miller, AA5PK

In Recognition of Your Outstanding Onboard Support of the 2016 AMSAT Space Symposium Cruise.

Frank Westphal, K6FW

In Recognition of Your Outstanding Onboard Support of the 2016 AMSAT Space Symposium Cruise.

Chad Phillips, KG0MW

In Recognition of Your Outstanding Onboard Support of the 2016 AMSAT Space Symposium Cruise.

Human Spaceflight

Debra Johnson, K1DMJ

In recognition of your outstanding support to enhance ARISS Educational Outcomes and your leadership as an executive of the ARISS-US team.

Your careful guidance and leadership during this critical year as we continue to transition ARISS into an externally funded organization are especially appreciated.

Dave Jordan, AA4KN

In recognition of your outstanding support to ARISS as the lead developer of our benefactor weekly report (AKA PSC Weekly), your international leadership of ARISS Public Relations and your support as a school mentor.

Ciaran Morgan, M0XTD

In recognition of your outstanding support as leader of the ARISS Principia initiative as part of Astronaut Tim Peake's mission.

Your leadership and drive resulted in one of the largest and most in-depth STEM education activities that AMSAT and ARISS have ever accomplished. Also, the HamTV downlinks, inaugurated as part of Principia, demonstrated the true essence of ham radio experimentation and education to hams, students and the general public.

Kenneth Ransom, N5VHO

In recognition of your sustained, phenomenal dedication to ARISS during this critical year of transition and change.

Our heartfelt thanks and admiration to you for your outstanding support. We also want to recognize your efforts to help the executive team make the changes necessary to improve the effectiveness of ARISS.

Rosalie White, K1STO

In recognition of your phenomenal leadership as the ARISS-US delegate, your sustained efforts as the ARISS Secretary/Treasurer and your superb support as a U.S. Executive team member.

Most importantly, you have worked tirelessly to raise awareness of ARISS inside and outside the amateur radio community in an effort to garner funding and support to ARISS. Your careful guidance and leadership during this critical year of ARISS transition and sustainment were particularly noteworthy.

John Kludt, K4SQC

In recognition of your outstanding, impactful service to the ARISS and AMSAT. We commend your support as one of our most productive school mentors.

Your phenomenal support as one of the lead presenters at the ARISS Information Sessions is also recognized and appreciated. AMSAT and ARISS are deeply indebted to you for your sustained, exceptional service.

Educational Relations

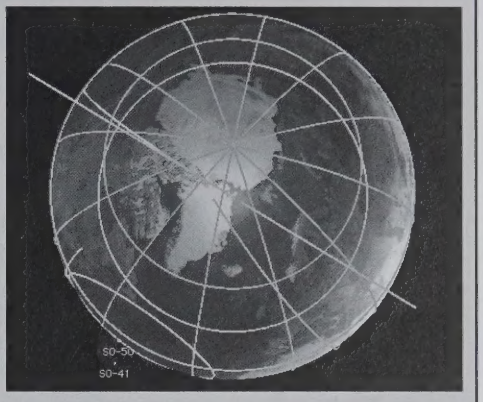
EMike McCardel, AA8EM

In Recognition of Your Outstanding Contributions to AMSAT Educational Relations

Thank you for serving as AMSAT Vice President, Educational Relations in 2015/2016.

MacDoppler

The premier Satellite tracking and station automation application for the Macintosh - OS 9 & OS X



MacDoppler for Cocoa gives you a seat right in the heart of the Operations & Command Centre for every satellite in orbit, providing any level of station automation you need from assisted Doppler Tuning and Antenna Pointing right on up to a fully automated Satellite Gateway!

It will calculate the position and relative velocity of the satellites you are tracking and automatically adjust the Doppler shift on both transmit and receive as well as pointing your antennas with predictive dead spot crossing so that a pass is never interrupted.

A Universal Binary that runs native on Intel and PPC Macs and provides separate panels for the map (2D or 3D), the radio and rotor controls, a sorted table of upcoming satellite passes and a Horizon panel that graphs upcoming passes as a function of elevation over time.

Now available from AMSAT at a special member discount donation!

martha@amsat.org
10605 Concord St. Suite 304
Kensington MD
20895-2526 USA.
(301) 822-4376, (301) 822-4371 (Fax)

Dog Park Software Ltd.
www.dogparksoftware.com

Support AMSAT

AMSAT is the North American distributor of SatPC32, a tracking program for ham satellite applications. For Windows 98, NT, ME, 2000, XP, Vista, Windows 7, 8/8.1 & 10.

Version 12.8c is compatible with Windows 7, 8/8.1 & 10 and features enhanced support for tuning multiple radios.

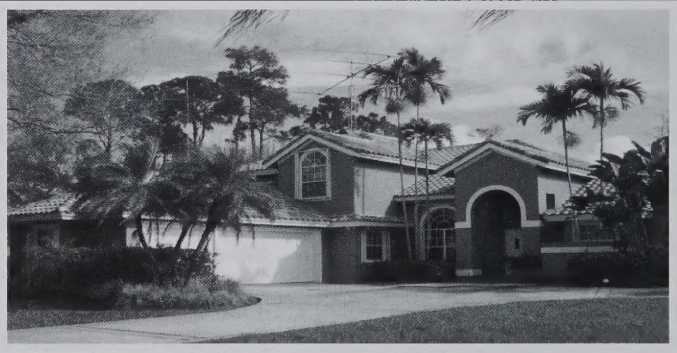
Version 12.8c features:

- SatPC32, SatPC32ISS, Wisat32 and SuM now support rotor control of the M2 RC-2800 rotor system.
- The CAT control functions of SatPC32, SatPC32ISS and Wisat32 have been expanded. The programs now provide CAT control of the new Icom transceiver IC-9100.
- The main windows of SatPC32 and SatPC32ISS have been slightly changed to make them clearer. With window size W3 the world map can be stretched (only SatPC32).
- The accuracy of the rotor positions can now be adjusted for the particular rotor controller. SatPC32 therefore can output the rotor positions with 0, 1 or 2 decimals. Corrections of the antenna positions can automatically be saved. In previous versions that had to be done manually.
- The tool "DataBackup" has been added. The tool allows users to save the SatPC32 program data via mouse click and to restore them if necessary. After the program has been configured for the user's equipment the settings should be saved with 'DataBackup'. If problems occur later, the program can easily restore the working configuration.
- The rotor interfaces IF-100, FODTrack, RifPC and KCT require the kernel driver IOPort.SYS to be installed. Since it is a 32-bit driver it will not work on 64-bit Windows systems. On such systems the driver can cause error messages. To prevent such messages the driver can now optionally be deactivated.
- SuM now outputs a DDE string with azimuth and elevation, that can be evaluated by client programs. Some demo files show how to program and configure the client.

Minimum Donation is $45 for AMSAT members, $50 for non-members, on CD-ROM.
A demo version may be downloaded from http://www.dk1tb.de/indexeng.htm
A registration password for the demo version may be obtained for a minimum donation of $40 for members and $45 for non-members.
Order by calling 1-888-322-6728.

The author DK1TB donated SatPC32 to AMSAT. All proceeds support AMSAT.

How would you like to be consistently told that you have the strongest signal on the band! Do it from Sunny Florida with no HOA restrictions!



I am selling my QTH in Wellington, Florida, near West Palm Beach. Fully approved and inspected 4 Element SteppIR beam at 60 feet on a motorized crank up tower with ORION rotator. Many other antennas including 80 Meter Inverted Vee, Full Size all band flat top with open wire feeders, 160M sloper, all band Vertical, 2m/432 Az/El on separate stub tower, separate 6M Beam on Stub Tower, 2m Vertical, and room for many more.

One of Florida's most prestigious communities. 4,774 sq. ft. custom home. 4 B/R, 3.5 BA, 20'x17' family room, plus 15'x25' den/office/hamshack with 240V service. Oversized 3 car garage. Heated pool, 1800 sq. ft. screened deck. 1.24 Acres in exclusive neighborhood.

1/2 court basketball court, 10x30 screened patio, accordion hurricane shutters on every door and window. Florida's highest rated public schools. Built in 1993. 2 bedrooms on the main floor, plus a second floor with two additional bedrooms and recreation room. 3 Zone air conditioning, with super high efficiency units.

First floor den is 15x25, which I have separated using a movable partition into a 15x17 office/ham station, and a 8x15 workshop. Office/ham station has a 15 foot wall of built-ins providing massive storage space. Beautiful wooded and landscaped lot. Local schools all "A" rated, with Palm Beach County's highest rated elementary school one block away. Great location, 12 miles from the ocean, 20 minutes to Palm Beach International Airport, and 1 hour to Miami International. Local shopping within a mile and a major regional mall 6 miles away. 10 Minutes to Turnpike, 20 minutes to I-95. Of course, tennis, golf, equestrian trails, private airstrip, all within a few minutes' drive or bike ride.

This is a dream location, in an area of Florida where nearly every other community has deed restrictions against any kind of exterior antennas. I have enjoyed this QTH for 20 years, but time has come to move on to something smaller. Priced below comparables at $895,000. House across the street sold at $1.4 M and next door recently custom built for $1 Million. Contact K4YV@bellsouth.net for details or 561-753-4947.

AMSAT Fox-1Cliff & Fox-1D $125,000 Launch Initiative Goal

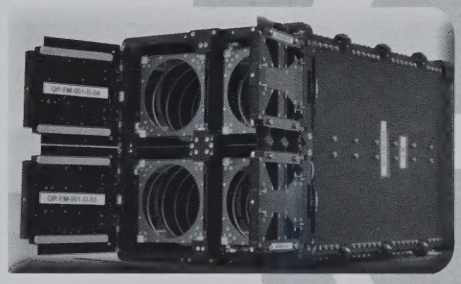
AMSAT is excited to announce a launch opportunity for **BOTH** the Fox-1Cliff and Fox-1D Cubesats. In response to a breaking opportunity, AMSAT and Spaceflight, Inc. have arranged for Fox-1D to accompany Fox-1Cliff on the maiden flight of the SHERPA system on a SpaceX Falcon 9 in the 1st quarter of 2016.

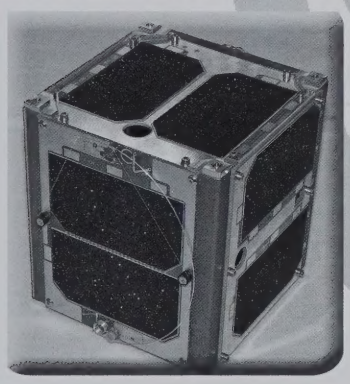
Fox-1Cliff and Fox-1D will provide selectable U/V or L/V repeater capabilities on separate frequencies once in orbit, and will be capable of downlinking Earth images from the Virginia Tech camera experiment.

AMSAT has an immediate need to raise funds to cover both the launch contract and additional materials for construction and testing for Fox-1Cliff and Fox-1D. We have set a fundraising goal of $125,000 to cover these expenses over the next 12 months, and allow us to continue to keep amateur radio in space.

Spaceflight's SHERPA will deploy multiple cubesat payloads on-orbit

ISIS QuadPack Nanosatellite Dispenser





Your help is needed to get the AMSAT Fox-1Cliff and Fox-1D 1U Cubesats launched on the Spaceflight's initial SHERPA flight.

For the latest news on Fox-1 watch our website at www.amsat.org, follow us on Twitter at "AMSAT", or on Facebook as "The Radio Amateur Satellite Corporation" for continuing news and opportunities for support.

Donations may be made through the AMSAT webpage at www.amsat.org, by calling (888) 322-6728 or by mail to the AMSAT office at 10605 Concord Street, Kensington, MD 20895, USA. Please consider a recurring, club, or corporate donation to maximize our chance of success with this mission.

AMSAT President's Club Support Fox-1Cliff and Fox-1D

Contribute to AMSAT directly through easy, automatic charges to your credit card. Since AMSAT is a 501(C)(3) organization donations may be USA tax deductible. (Check with your tax advisor.) To join contact Martha at the AMSAT Office by phone (888) 322-6728 in the US, or (301) 822-4376; e-mail **martha@amsat.org**.

Titanium Donors contribute at least US $400 per month	❒	$400 / month
	❒	$4800 one time
Platinum Donors contribute at least US $200 per month	❒	$200 / month
	❒	$2400 one time
Gold Donors contribute at least US $100 per month	❒	$100 / month
	❒	$1200 one time
Silver Donors contribute at least US $50 per month	❒	$50 / month
	❒	$600 one time
Bronze Donors contribute at least US $25 per month	❒	$25 / month
	❒	$300 one time
Core Donors contribute at least US $10 per month	❒	$10 / month
	❒	$120 one time

AMSAT is Amateur Radio in Space ... and YOU are AMSAT!

Seize opportunities to launch your amateur radio experience to new heights!

ARISS Development and Support

AMSAT's Human Space Flight Team is looking for volunteers to help with development and support of the ARISS program:

- Mentors for school contacts
- Support for the ARISS web
- Hardware development for spaceflight and ground stations
- Help with QSL and awards certificate mailing.

To volunteer send an e-mail describing your area of expertise to Frank Bauer at: **ka3hdo@amsat.org.**

AMSAT Internet Presence

AMSAT's information technology team has immediate needs for volunteers to help with development and on-going support of our internet presence
:

- Satellite status updating and reporting.
- Add/delete satellites to ANS and the web as needed.
- Research and report satellite details including frequencies, beacons, operating modes.
- Manage AMSAT's Facebook and Twitter presence.

To volunteer, send an e-mail to Drew Glasbrenner, KO4MA at: **ko4ma@amsat.org**.

AMSAT Engineering Team

AMSAT Engineering is looking for hams with experience in the following areas:

- Attitude Determination and Control, and Thermal Engineering, to help in the design of high orbit CubeSats.
- Power systems, for CubeSats from 1U through 6U and LEO to HEO.
- Help with solar, power supply, and battery design for both LEO and HEO missions.
- Logistics, for parts procurement, inventory, and distribution.
- Documentation, for designs, tests, and public relations.

To volunteer, please describe your expertise using the form at **ww2.amsat.org/?page_id=1121.**

AMSAT User Services

AMSAT is looking for an on-line store co-manager to update and refresh the AMSAT Store web page when new merchandise becomes available or prices and shipping costs change.

- Add new merchandise offerings
- Delete merchandise no longer available
- Update shipping costs as needed
- Add periodic updates for event registrations
- Interface with the AMSAT Office

To volunteer, send an e-mail to Joe Kornowski, KB6IGK at: **kb6igk@amsat.org**

AMSAT Educational Relations Team

AMSAT's Educational Relations Team needs volunteers with a background in education and classroom lesson development ...

- Engage the educational community through presentations of how we can assist teaching about space in the classroom.
- Create scientific and engineering experiments packaged for the classroom.
- Create methods to display and analyze experimental data received from Fox-1.

To volunteer send an e-mail describing your area of expertise to Joe Spier, K6WAO at: **k6wao@amsat.org**.

AMSAT Field Operations

AMSAT's Field Operations Team is looking for satellite operators to promote amateur radio in space with hands-on demonstrations and presentations.

- Promote AMSAT at hamfests
- Setup and operate satellite demonstrations at hamfests.
- Provide presentations at club meetings.
- Show amateur radio in space at Dayton, Pacificon, Orlando Hamcation.

To volunteer, send an e-mail to Patrick Stoddard, WD9EWK at: **wd9ewk@amsat.org**

You can find more information on the web:
www.amsat.org – click AMSAT – then click Volunteer